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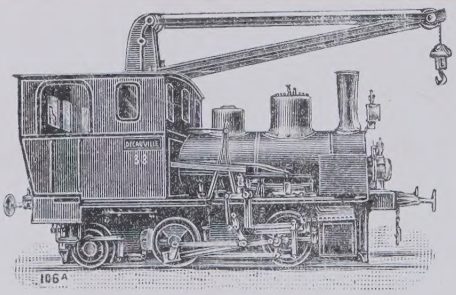

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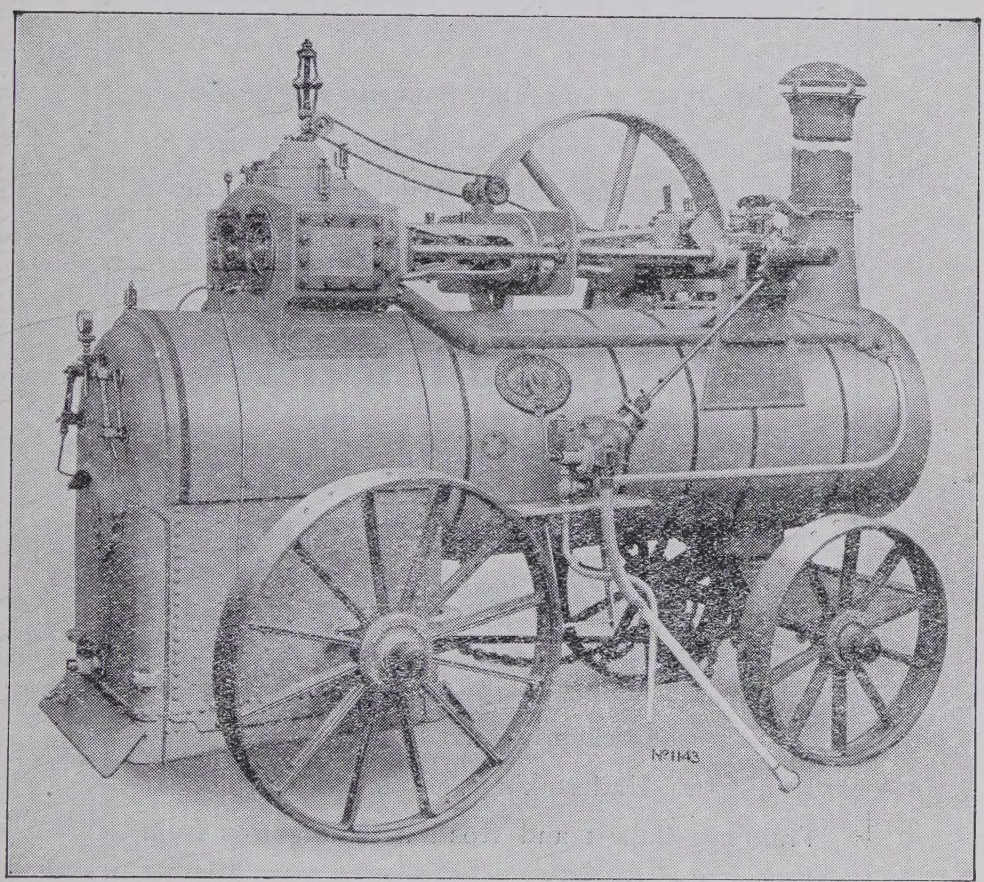

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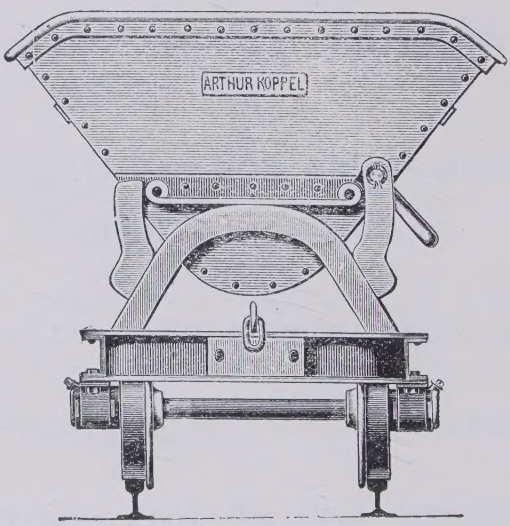

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The

Ways of our Light Railways

by

Edward Harran.

CALCUTTA
The Indian Railway Gazette.

1910

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AUTHOR'S NOTE.

In presenting this work to the public, the author is conscious of many shortcomings in it and in the descriptions given of the various light railways noticed. It will be seen that of the large number of light lines in India, mention has been omitted of many, not because these are uninteresting or of little value, but because on account of limitations of space it has been thought advisable to select only a small number and give as complete a description of these as possible in preference to mentioning all, or most, of the many light railways in the country and only giving a few notes with regard to each, all that would be possible were one and all, or even the majority, included in the work.

While every endeavour has been made to substantiate the facts given, it is perhaps possible that here and there inaccuracies have crept in and escaped notice and the writer will take it as a favour if with a view to preventing their repetition in subsequent editions, anyone detecting these will be kind enough to point them out.

Much of the information given in the present volume has appeared in a series of articles entitled "Indian Light Railways and their Rolling Stock" which the writer contributed to the columns of *The Indian Railway Gazette* and he is indebted to the courtesy of the Editor of that periodical for permission to reproduce it. The writer also desires to express his thanks to the firms of Messrs. the Decauville Company, Orenstein and Arthur Koppel, Messrs. Burn & Co., Ld., and Mr. Krishna C. Dey (of Messrs. K. M. Dey & Co.) for the assistance they have given him and for having provided some of the photographs from which illustrations have been reproduced.

E. H.

THE WAYS OF OUR LIGHT RAILWAYS.

INDEX.

CHAPTER.		PAGE.
I.	THE STORY OF THE LIGHT RAILWAY IN INDIA	1
II.	MOUNTAIN RAILWAYS	11
	The Matheran Light Railway... ...	13
	The Kalka-Simla Railway	15
III.	FOREST AND PLANTATION LIGHT RAILWAYS ...	17
	The Cochin Forest State Railway ...	19
	The Goalpara Forest Tramway ...	27
	The Tezpore-Balipara Railway ...	34
IV.	THE BENGAL-NAGPUR RAILWAY SPECIAL GAUGE LINES	39
	The Jubbulpore-Gondia Extension ...	42
	The Purulia-Ranchi Branch ...	43
	The Raipur-Dhamtari Branch ...	44
	The Gondia-Chanda Extension ...	45
	The Mourbhanj State Railway ...	48
	The Parlakimedi Light Railway ...	50
V.	MINE TRAMWAYS	53
	The Gangpur Light Railway	55
	The Tumsar Road-Katangi Light Railway	56
	The Balasore-Nilgiri Light Railway ...	58
VI.	TEMPORARY MILITARY LIGHT RAILWAYS ...	61
	The Delhi Durbar Light Railway ...	63
VII.	GENERAL TRAFFIC LIGHT RAILWAYS ...	67
	The Bengal Provincial Railway ...	69
	The Gwalior Light Railway	72
	The Jorhat State Railway	74
	The Cooch Behar State Railway ...	75
	The Powayan Steam Tramway ...	77
	The Gaekwar's Dabhoi State Railway ...	79

LIST OF ILLUSTRATIONS.

FRONTISPIECE.

1. A Kalka-Simla Railway Train ... Page xvi.
2. A Matheran Light Railway Locomotive ... To face page 13.
3. View from Kathlighat Station, Kalka-Simla Railway ... ... To face page 15.
4. Barogh Tunnel, Kalka-Simla Railway ... To face page 16.
5. Barogh Station, Kalka-Simla Railway ... To face page 16.
6. Cutting near Salogra, Kalka-Simla Railway To face page 17.
7. Cochin State Gazette Extraordinary ... To face page 19.
8. Double-railed, Self-acting Incline Way on the Cochin Forest Tramway ... } To face page 20.
9. Another view of the same Incline ... }
10. Another Incline on the Cochin Forest Tramway ... ... To face page 21.
11. General view of a portion of the Main Line of the Cochin Forest Tramway ... To face page 22.
12. A Locomotive, Truck and Brake-Van, Cochin Forest Tramway ... ... } To face page 23.
13. Train of Trucks on the Cochin Forest Tramway ... ... }
14-15. Bridges on the Cochin Forest Tramway To face page 24, 25.
16. A Clearing in the Forest ... ... To face page 27.
17. Patent Roller-bearing Axle-box used on Goalpara Forest Tramway Stock ... Page 32.
18. Semi-enclosed Passenger Car, Tezpore-Balipara Light Railway ... ... To face page 37.
19. Locomotive, Raipur-Dhamtari Branch ... Opposite page 44.
20. Locomotive, Gondia-Chanda Extension ... Opposite page 46.
21. Composite Carriage, Gondia-Chanda Extension ... ... Opposite page 46.
22. Composite Carriage, Gondia-Chanda Extension ... ... Opposite page 47
23. Third Class Carriage, Gondia-Chanda Extension ... ... Opposite page 47.

LIST OF ILLUSTRATIONS.—(*Contd.*)

24. Interior of First Class Carriage, Gondia-Chanda Extension ... ... Opposite page 48.
25. Horse-box, Purulia-Ranchi Branch, Bengal-Nagpur Railway ... ... To face page 43.
26 Covered Goods Wagon, Mourbhanj State Railway ... ... To face page 49.
27. First Class Passenger Coach, Mourbhanj State Railway ... ... To face page 50
28. Composite Brake, Luggage and Postal Van, Mourbhanj State Railway... ... To face page 51.
29. Crabb Nulla Bridge, Gangpur Light Railway To face page 55.
30. A Bridge, Gangpur Light Railway ... } To face page 56.
31. Locomotive and Trucks, Gangpur Light Railway ... ... }
32. Wagon for carriage of Manganese Ore, Tumsar Road-Katangi Light Railway To face page 57.
33. High-capacity Self-discharging Ore Wagon, 2′ 6″ gauge ... ... To face page 58.
34. View on the Balasore-Nilgiri Light Railway To face page 59.
35. A Locomotive, Balasore-Nilgiri Light Railway ... ... To face page 60.
36. Truck used on the Delhi Durbar Light Railway ... ... To face page 64.
37. Military Ambulance Truck ... ... To face page 65.
38. Composite Carriage, Bengal Provincial Railway ... ... To face page 69.
39. Combined Third Class Carriage and Brake Van, Bengal Provincial Railway ... To face page 70.
40. Covered Goods Wagon, Bengal Provincial Railway ... ... To face page 71
41. Open-sided Third Class Passenger Carriage, Bengal Provincial Railway ... To face page 72.
42. Locomotive, Cooch Behar State Railway ... To face page 75.
43. First and Second Class Composite Passenger Coach, Cooch Behar State Railway ... To face page 76.
44. Iron Covered Goods Wagon, Cooch Behar State Railway ... ... To face page 77.
45. Four-coupled Tank Engine, 2′ gauge ... To face page 79.
46. Six-coupled Tank Engine, 2′ 6″ gaage ... To face page 81.

A KALKA-SIMLA RAILWAY TRAIN.

The whole of the stock, both Passenger and Goods, on the Kalka-Simla Railway is fitted, or is being fitted, with Jepson's Patent Automatic Buffer Coupler.

THE WAYS OF OUR LIGHT RAILWAYS.

THE STORY OF THE LIGHT RAILWAY IN INDIA.

At the end of the month of March 1908 there were 30,206 miles of open railway line throughout India, of which no less than 1,576 miles were what is technically known as light line or special gauge railways. Of these 1,576 miles, 1,234 miles are on the 2 feet 6 inch gauge and 342 miles on the 2 feet gauge.

Statistics or figures at the best of times make dry reading, and when the opening lines of a volume consist of them, it may be thought that the pages which follow will contain more. Fortunately, in the present case, this is not altogether so, the opening figures being merely reproduced from the Administration Report of the Railway Board so as to shew that, if only on account of their total length in India, light railways are playing an important part in the country. The construction of the first metre (3 feet 3⅜ inch) gauge line out here gave rise to a controversy which has been intermittently renewed in varying degrees of languidness or severity down to the present time, and which is best described by the name that is generally applied to it in the local Press—"the battle of the gauges." While it has been, and is, held on the one side that the greatest mistake ever made by those who have directed Indian railway policy was the first departure from a uniform standard of gauge throughout the whole country and that this mistake is being perpetuated with every additional mile of metre gauge to the construction of which official sanction is accorded, it has been, and is, held on the other side that the introduction and spread of the 3 feet 3⅜ inch gauge of railway has given an impetus to railway progress and development which these would not have received had the broad or standard gauge been rigidly adhered to, because principally on account of financial considerations, many miles of railway line which have been laid on the metre gauge would not be existent to-day had the construction of standard gauge lines or none at all always been insisted upon. This latter argument

is advanced a further stage by the somewhat widely expressed opinion that the metre gauge is responsible for the present commercial and agricultural development and prosperity of many a district, and even province, in this country ; that is, these particular portions of the land would not have reached the state of development they are now in if it had not been for the advent throughout, or in parts of, their area of the metre gauge railway. Had they had to depend upon being served by a standard gauge line, they would probably have been waiting yet and would of course have been in a corresponding state of backwardness. The arguments put forward by the opponents of the metre gauge have also been held, by some though not generally, to apply also to the construction of narrow gauge lines. These arguments are definite and are briefly as follows :—

The results of working metre or narrow gauge lines are financially such as to ultimately not justify the initial saving in capital outlay on construction. It is argued that presuming the construction and equipment of a broad gauge line through a given area could be accomplished for the sum of two lakhs of rupees a mile bearing interest at 3 per cent. and the construction of a narrow gauge line through the same area, and of the same length, for a sum of half a lakh a mile at the same rate of interest, the recurring cost of transhipment, that is, expense of the necessary staff and cost of handling and rehandling generally, payment of claims arising out of such transhipment, cost of providing narrow gauge stock when if the line was on the broad gauge the same stock could run through, is more than the difference between the lesser and greater interest payable on the capital outlay. Therefore, while there is in the initial an admitted substantial saving in capital outlay, a permanent charge is settled upon the working of the line built for the lesser sum which is greater than the interest would be had the larger sum been expended in the first instance and a broad gauge line constructed. Taking the figures already given, two lakhs per mile for the broad gauge line and half a lakh per mile for the narrow gauge, both sums bearing interest at 3 per cent., it is argued that the cost of the break of gauge will average more per annum than the sum of Rs. 4,500 per mile per annum, which represents the difference between the lesser and greater amount of interest payable. It is no part of the writer's purpose to enter into the arena of this controversy. His opinion is that whatever may be said as to the respective merits of the broad and metre

gauges, there can be no two questions on the subject when special or narrow gauge lines are under review. The argument of " break of gauge " cannot in any way be applied to them as they are not trunk lines in the sense that metre gauge ones are—they serve mainly as feeders to trunk lines of both gauges and are never, or at any rate should never be, meant to compete with and draw traffic from the main lines. Their utility, if only in this respect, should therefore be beyond controversy. They have, since they were first initiated, played a most important part in the development of the country—a part which they continue to play at the present day with greater prominence and success than ever. They have served to connect sparsely populated or barren tracts of country, where the capital outlay necessitated by the construction of a standard or metre gauge line would not be justified from a financial or any other point of view under prevalent conditions, with the great trunk lines which spread throughout the provinces and are the main arteries of the enormous volume of railway traffic that is carried yearly throughout the Indian Empire. They have served to bring Plain stations into touch with the Hills by pushing their way up mountain sides and over gorges inaccessible to the ordinary railway and only made accessible to the special gauge by modern engineering genius. They have rendered possible the opening out of country endowed with untold mineral wealth and vast agricultural possibilities, and the subsequent development of it by providing means for transporting men and machinery to the points of operation and of thereafter carrying away the output of the mines and the crops of the land to where these can be carried onwards over main railway lines or by river for sale and use in the great centres of industry of the country or shipped from the ports of India to the ports of the world. They have penetrated to places and over country where, either on account of natural obstacles or through lack of capital, heavier lines cannot go or have not gone, with the result that they have, practically speaking, been the means of having the names of such places marked upon the map of the civilized world, and bringing them into touch with civilization, the progressive civilization of the West which is so rapidly permeating every corner of the hitherto peaceful and placid Orient, now fast awakening to modern day influences, of which the greatest by far is the railway. All this light railways have done in India in the past and will, as natural and indispensable accessories of the civilization referred to, continue to do during the

time of the present and rising generations and beyond. To them the commercial and industrial public of the cities of India owe at least a measure of the prosperity which they have attained, while dwellers in the country, agriculturists and others, must be aware that the advent of the narrow gauge railway has been the means of placing at least a number of them in a position of greater comfort, if not of affluence, than they had ever before dreamt of reaching.

So much has the light railway done in the direction indicated. In at least one other it has done if anything more. The resident in India does not need to be told of the famines which, from one cause or another, visit certain portions of the country with recurring frequency—famines which the spread of irrigation has perhaps stemmed, but has not yet lessened to any really appreciable extent—famines which in the past used to decimate whole tracts of country, rendering the lands barren and bare, driving the peasants from their homes, the zemindars from their estates and the ryats from their holdings. The advent of the light railway in districts subject to these famines although many miles of it have been built expressly for famine service notably the lines of the Central Provinces, has not, it it true, had any effect in preventing the recurring visitations, but it has had the effect of greatly mitigating the severity of these upon the inhabitants by providing means of transporting food from more favoured districts to the stricken ones, and by enabling assistance to be rendered speedily, without any of the delays attendant upon road transportation in pre-railway days, and in sufficient volume to be really efficient and not merely scratch the fringe or outer portion of a famine area. The famine lines of India are among the greatest assets the country possesses to-day. None has been laid without long and mature deliberation. The policy dictating their construction has been a studiously calculated one, and has been carefully pursued. The cost has been counted, the prospective benefit to be ultimately derived has been weighed, and the result is the presence of a number of a lines from which not only the districts concerned, and the country generally, are reaping the utmost benefit but the promotors also are profiting financially. The present Chief Commissioner of the Central Provinces in the course of a speech delivered in November 1908 at the opening ceremony of the Gondia-Chanda Light Railway (a project of the Bengal-Nagpur Railway Company initiated by Sir T. R. Wynne, then Agent of that line and now President of the Railway Board) stated—and he doubtless had figures at his command when

making the statement—that while the primary object of certain light lines in the Central Provinces was to enable famine areas to be served with facility from better favoured districts, they being, in other words, famine lines purely and simply, it does not follow that a famine line is one which cannot be made to pay, to become a financial success. Actual practice in India, it was stated in the speech under notice, shews that many of the light lines originally constructed to serve districts in provinces where famine is usually the feature, not the exception, are to-day bringing handsome returns to their promotors. Unquestionably one reason for this is that these lines have opened out the areas of country affected, broadened the basis of trade and inter-district and inter-provincial exchange and barter and communication, and, generally, infused a fresh, healthy and hopeful spirit into the inhabitants of the country through which the lines now run. There is yet a further reason which will be referred to later. The Agent of the Bengal-Nagpur Railway, Mr. J. A Manson, once defining the objects of a light railway scheme his Company had in hand, one that was then approaching completion, stated them to be :—

(a) The opening out of the agricultural and mineral resources of large and important areas hitherto practically cut off from all communication with other parts of India.

(b) To facilitate people settling on rich tracts of land now waste, but capable of supporting a large population.

(c) To provide means of protecting the inhabitants in times of famine.

With the exception of such lines as are expressly built for one specific purpose, the three objects indicated are practically the *raison d'etre* for the construction of every light line in India, and the statement with regard to them could not possibly have been more concisely or lucidly framed. As had just been said, there are exceptions, such, for instance, as the Kalka-Simla Railway, which was constructed for the sole purpose of linking Simla with the Plains—the Darjeeling-Himalayan Railway which was expressly designed to afford access, within comparatively easy reach of Calcutta, to the Himalayas—the Matheran Light Railway connecting the Hill resort of Matheran with the Plain station of Neral on the Great Indian Peninsula Railway, the Cochin Forest State Railway

constructed to serve the timber interests of the State, and a number of others built specially to serve coal and manganese mines, forest areas and tea gardens. Of such lines as these it might perhaps be said that they are not general utility lines. They have been constructed for a special purpose and they serve that purpose, but while they undoubtedly, each and all, do their part, be it ever so small a one, in assisting industrial development they do not form an asset of such value to the country at large and to its inhabitants as do famine lines, or lines which have been laid as a commercial venture for purposes of general transportation. Still, whether a light railway be built for a specific purpose or for purposes of general utility it remains a light railway, the output of modern engineering genius and present day civilization and as such it is a notable object and the study of it and its ways one of interest and possible value to the student and the railwayman.

Certain reasons have been given for the, in some cases, comparatively handsome returns that some light line ventures in India are to-day bringing to their promotors and it has been said that, in addition to those mentioned, there is yet a further reason for this. We now pass to this. There are but few light railways in India which have been constructed by and are worked directly under the auspices of the Government. There are a few, but not a large number, that have been constructed and are worked by railway companies who are already in possession of many hundreds of miles of open trunk line—the Bengal-Nagpur Railway Company for example. The greater number by far are due either to the enterprise of Local or District Boards or to that of private firms, frequently to the two working in conjunction. In this connection the following extract from "Railed Roads," a most interesting and useful little volume the author of which is Mr. Francis J. E. Spring C.I.E. L.C E, Chief Engineer in the Indian Public Works Department and Chairman and Chief Engineer of the Madras Port Trust, is very much to the point:—

> "I venture to predict that a most important railway development in India in the early future will be the great extension of cheap light £1,500 to £2,000 (Rs. 22,500 to Rs. 30,000) per mile railways, intended to serve, not as trunk lines, but as feeders to our 5 feet 6-inch and metre gauge railways. If the extension of our Indian railways is to progress at a rate commensurate with its importance as an

enriching, a safe-guarding and a civilizing influence, trunk lines will suffice in themselves to fully occupy the attention of, and to absorb the borrowed funds of, the Government of India. The extension, therefore, of little railways of local interest must necessarily be left to the care of those local self-governing bodies who are immediately interested in them."

These lines were written ten years ago, but the development foreseen by Mr. Spring has occurred and is occurring, and District Boards are playing a prominent part in it. The District Board obtains a grant of the land for the firm and provides a guarantee, the firm finds the money and constructs and works the lines under that guarantee. Now rightly or wrongly business men in India do not give the Government of the country much credit for business-like habits, more especially the administrations of State worked lines. No opinion is expressed on the point, but the feeling is there and it is noticed. Ordinary business men do not like the ways of the State lines, and when they begin to manage light lines on behalf of their firms they do not seek to emulate them, but go to work in another manner. They place finance as *the* foremost consideration in railway management as in any other undertaking they participate in. The line must, before anything else, be made to pay, with the Local Board or Government guarantee they hold if it cannot be otherwise managed, but preferably without the aid of it. To this end the best energies of men who are first and foremost business men are applied, and the hand of the management is apparent in the result of the working. This is the further reason that so many light lines in India are earning fair dividends. They are being run on business lines by business men, who want to see that full value is obtained for every pound expended, and that their lines carry the maximum amount of traffic obtainable not only in the ordinary run of work, but also such as can be obtained by advertising, canvassing or by any other means

Among Local Boards engaged in light railway enterprise, the Tanjore District Board has been a pioneer, and it has now a splendid property in its railway—one which habitually earns a net annual profit of close upon three lakhs of rupees, or 6·1 per cent. on its capital outlay. In 1907 the Southern Mahratta Railway, as it was then, completed the construction of the Bezwada-Masulipatam line on behalf of the Kishna District Board, the cost being met out of

a loan of 18½ lakhs taken from the Government. Among other light railway projects in the Presidency of Madras that have been taken in hand or sanctioned are the Nidamangalam and Vedaranirjan projects by the Tanjore District Board which are estimated to cost Rs. 4,68,559 and Rs. 9,08,958 respectively; the Guntur line, which is estimated to cost Rs. 26,47,213, by the Guntur Board; the Salem line, which is estimated to cost Rs. 15,20,803, by the Salem Board and the Tinnevelly line, which is estimated to cost Rs. 20,52,003, by the Tinnevelly Board. The cost of all these will be met in part from the accumulated surplus of the railway cess, and in part from local capital raised or to be raised on the guarantee of the District Board concerned. The expenditure of the sums mentioned in light railway construction in one province alone is sufficient indication of the enterprise that is behind these projects, and of the benefit that must accrue to the districts and their inhabitants generally from the laying out of these large sums within the province. For in this latter connection there is one point which is worth noticing and commenting on and that is that capital spent on light railway construction largely takes the form of local expenditure, proportionately less of the money being spent in obtaining material from other countries than is the case with broad gauge lines when under construction and being equipped for traffic. There is more than one engineering firm in India which is able to construct and equip a light railway from start to finish, and there are other firms, European ones, who can do so, and do so, through their agents or branch establishments out here. In the former category might be mentioned Messrs. Burn and Co. of Howrah and Jessop and Co. of Calcutta, while in the latter, the name of Messrs. Orenstein and Arthur Koppel of Calcutta, will readily occur to the light railway man. It is therefore apparent that light railway construction means, from the initial, much to the district in which the line is being laid and nearly as much to the country generally. When completed, it means more, and the country has acquired another valuable asset, usually one worthy of being both known and studied.

Among District Boards in Bengal which have been instrumental in promoting or assisting light railway ventures are those of Howrah, Hooghly, the 24-Purganas and Patna. The Howrah District Board guarantees to make up the earnings of the Howrah-Amta Light Railway when these are below Rs. 1,100 per annum per mile constructed

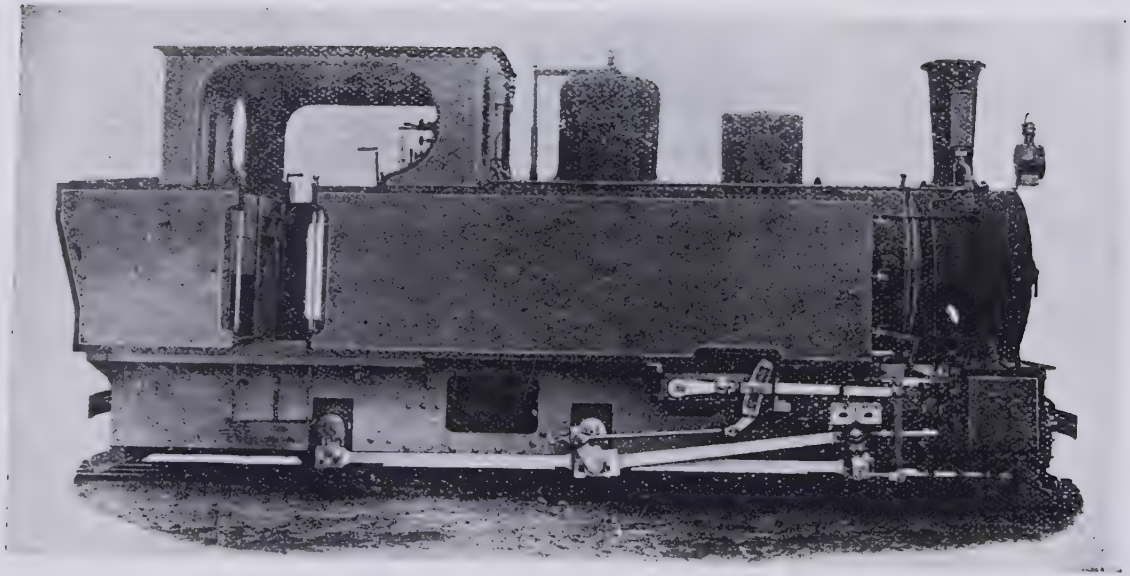
and opened, subject to a maximum annual subsidy of Rs. 28,000. The Hooghly District Board guarantees to make up the net earnings of the Howrah Sheakhalla Light Railway to Rs. 950 per annum per mile constructed and opened, while the same Board is also sponsor for the Tarkeshur-Magra Light Railway, which is worked by the Bengal Provincial Railway Company. The District Board of the 24-Purganas guarantees an annual maximum subsidy of Rs. 38,000 to the Baraset Basirhat Light Railway, and the District Board of Patna one of Rs. 32,000 to the Buktiarpur-Behar Light Railway. There are many such instances of co-operation in railway enterprize between the local Governments and large private firms. Even in Burma, a province which is generally regarded as being only in the early stages of developement, the influence of the light railway was acknowledged as long ago as 1883 when a Mr. G. E. L. Dawson constructed the Thaton-Duyinzaik line, a length of 7½ miles, which was opened to traffic in 1885 taken over by the Irrawaddy Flotilla Company in 1900, and finally closed to public traffic on the 15th of November 1907. This little line experienced in its time very little else but misfortune, but its history will doubtless serve as an experience to promotors who will come along in Burma in the future and they will profit accordingly.

It is with the object of making the light railways of India, their work and ways, better known that this volume is published, in the hope that it will prove of more than passing interest not only to the railway man and the engineer, but also to those who have a stake in India and are concerned in its commerce, its trade and its development generally.

MOUNTAIN RAILWAYS.

THE MATHERAN LIGHT RAILWAY

THE KALKA-SIMLA RAILWAY.



A LOCOMOTIVE, MATHERAN LIGHT RAILWAY.

MOUNTAIN RAILWAYS.

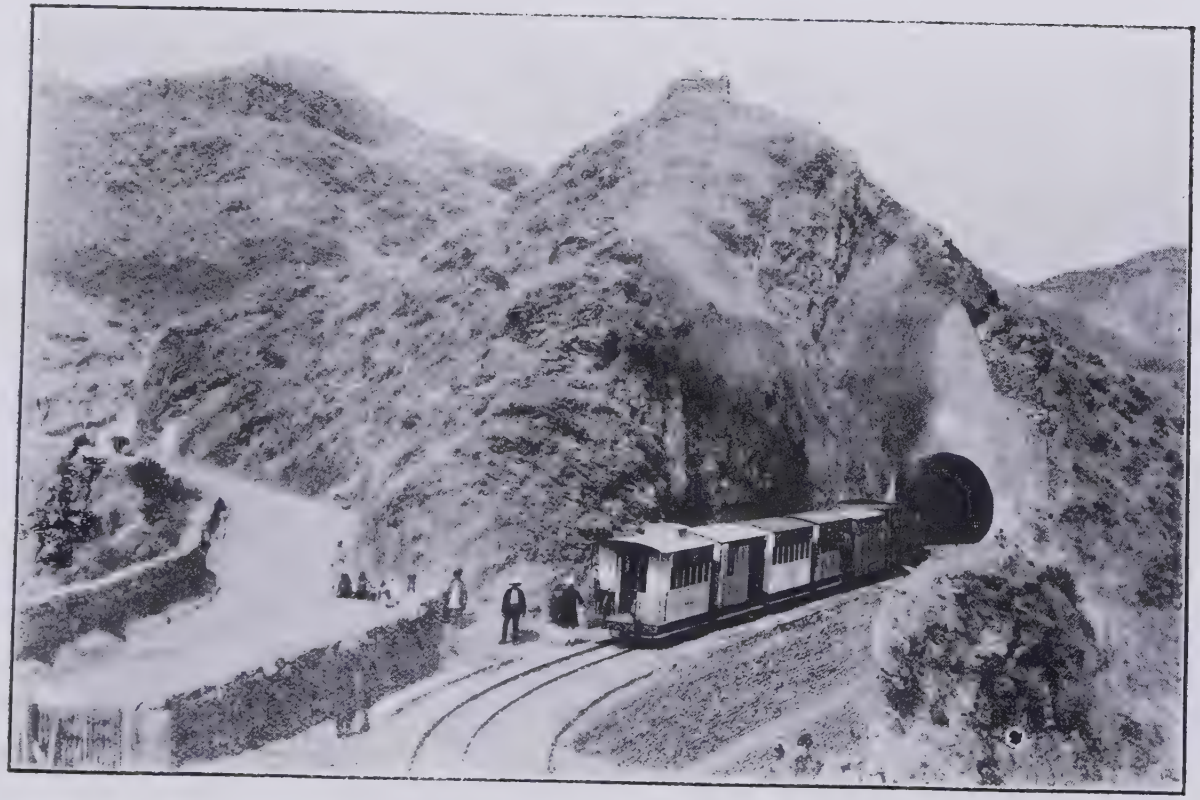
(1) THE MATHERAN LIGHT RAILWAY.

THIS is one of the most recently built light lines in India, its construction by Mr. Abdul Husein Adamjee Peerbhoy of Bombay having been authorized by Public Works Department (Bombay) notification No. 34, dated 28th July 1904, the line being opened to traffic in July 1907, up to which date Rs. 10,11,300 had been expended on its construction and equipment. Towards the end of 1908 it was successfully floated as a limited liability company with the promotor, Mr. A. H. A. Peerbhoy, as Chairman. It is worked on behalf of the proprietors by the Great Indian Peninsula Railway Company, which is, for the present, content to be re-imbursed for actual out-of-pocket expenses. The system is on the narrow or 2 foot gauge, 12·61 miles in length, connecting the Hill resort of Matheran with the Plain station of Neral on the Great Indian Peninsula Railway, the difference in height between the two places being some 2,400 feet. The maximum gradient throughout the length is the stiff one of 1 in 20 compensated and the minimum radius of curve is 60 feet. These features have rendered it necessary for the locomotives employed on the line to be of special construction, the particular points required being (1) great hauling power with a minimum of wheel pressure, this being necessary in view of the very light rails (30lbs. to the yard only) with which the track is laid, (2) a long wheelbase with great moveability in curves and equal spring load on either side of the end axles, to ensure smooth running, capability of taking the curves without shock or fear of derailment and with a minimum of wear and tear on rails and tyres. At the time of writing, the locomotive stock of the line consists of four engines, which were built by Messrs. Orenstein and Koppel (now Messrs. Orenstein and Arthur Koppel) of Berlin and Calcutta under the supervision of Messrs. E. R. Calthrop and Partners, Consulting Engineers. The same firm also supplied the wagon stock of the line and the points and crossings for the permanent-way. An illustration of one of the engines referred to is given, and the remaining three in use are of the

same type. The outside motion merits notice from mechanical engineers and its arrangement is very clearly indicated in the plate.

The permanent-way consists of 30lb. flat-footed steel rails laid on half-round Burmese teakwood and other wooden sleepers, while it is fully ballasted with broken stone. The traffic carried is principally passenger, but the earnings of the line were, up to the beginning of the year 1908, in defect, as they amounted to Rs. 17,529 only, representing Rs. 34 per open mile per week, or Rs. 172·92 per cent. of working expenses. With the increasing popularity of Matheran, however, as a hill resort, and the consequent enlargement of the station, the earnings of the line should improve, in fact, they did improve considerably during 1908, though figures to this effect are not available yet. The terms of the agreement between the promotor and the Government provide for the latter having the option of purchasing the system as a going concern on the 1st January 1940 or at the expiration of any subsequent period of 5 years at 25 times the average net earnings of the undertaking for the three calendar years immediately preceding the date of purchase. The Government has fixed certain maxima charges for passenger fares and the carriage of goods, and during the early period of working these maxima were imposed but are gradually being lowered to encourage traffic. It is noteworthy that the minima rates have not been fixed, an omission not usually made by the Government when entering into agreements with railway companies, but, in the case of the Matheran Railway, it is obvious that no purpose of any kind would be served by having done so, as no competition of any kind exists or is possible to induce the introduction of cut-throat rates. On the other hand, the object in fixing maxima rates and fares was undoubtedly to prevent the proprietors, working without any possibility of competition, from imposing excessive rates. It is improbable, however, that, in any case, such rates would have been imposed as they would only have strangled traffic, the very last thing a businesslike firm anxious for the success of a railway on the construction of which they had expended a large amount of capital would wish to do.

At present, the Matheran Light Railway cannot be counted among the financially successful light railway ventures in the country, whatever the future may hold, but it should, in the course of time from this point of view, unquestionably justify its construction,



VIEW FROM KATHLIGHAT STATION, KALKA-SIMLA RAILWAY.

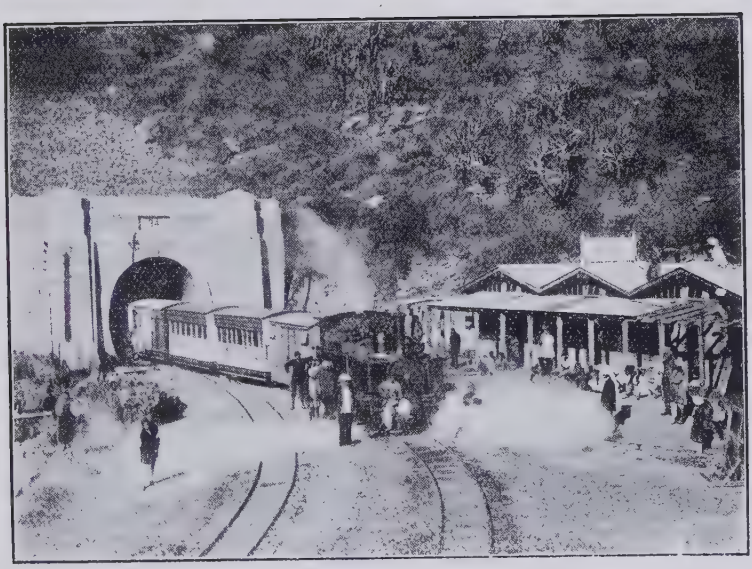
as it prospects appear fairly healthy and it has the advantage of being worked by a sound administration as is the Great Indian Peninsula Railway.

(2) THE KALKA-SIMLA RAILWAY.

A SOMEWHAT different class of light line is that which enables the traveller to reach the lofty mountain heights of Simla. The broad gauge line of the Delhi-Umballa-Kalka Railway terminates at Kalka and from there to Simla a distance of thirty-eight miles, the Kalka-Simla Railway climbs the Himalayas. The Company which built it was formed in 1899, and in that year Mr. Harrington, then the Company's Chief Engineer, commenced the supervision of operations. The task was a formidable one. The hillsides, both steep and rugged, left scarcely a yard of easy work, and from start to finish the work consisted of overcoming natural obstacles, and taking what advantage was possible of the contours of spurs, saddles, etc. It was not until the year 1903 that the line was at last opened through to Simla, and the capital expended on its construction had been over one million pounds sterling. It is this enormous capital expenditure on a comparatively short length that has been the millstone of the line and has prevented it becoming, so far, a paying concern in spite of the fact that the proportion of working expenses to earnings, which was 78·09 on the first year's working, had, for 1907, been reduced to 56·22 per cent. The gross earnings have been steadily on an ascendant scale, reaching in 1907 the sum of Rs. 9,25,979, which represented Rs. 300 per mile per week. This, however, was insufficient to pay the heavy interest charges, and the Company, to save further loss, sold the line to the Government for £300,000 in 1906, the Government also waiving its claim to all arrears of unpaid interest due to it by the Company for advances made. The North-Western Railway administration assumed full control of the line on the 1st January 1907 and have worked it since.

The Kalka-Simla Railway is 59·44 miles long on the 2 feet 6 inch gauge. The permanent-way consists of 46¼lb. flat-footed steel rails laid on wooden sleepers, the road being ballasted with stone. Most of the curves are compound, the limiting radius being 120 feet and the ruling gradient is the steep one of 1 in 33. In construction, the difficulty experienced in obtaining a sufficient

length of line to account for the necessary rise, in some of the steeper parts of the hillsides, with the maximum gradient accepted, has resulted in the adoption of a number of those distorted spirals which always form an interesting feature in the panorama of mountain railways. There are no less than 103 tunnels on the line, some of them of a fair length, in fact, the Barogh Tunnel, which is 3,752 feet long, is the second longest railway tunnel in India. Kalka is at an elevation of 2,143 feet above sea level, Solon 5,100 feet and Simla 7,100 feet, the difference in temperature between the first and last at the same time being frequently as much as 20 degrees. The tunnels already mentioned have an effect upon the rates charged for the carriage of goods and upon passenger fares, as the maxima and minima charges between which the authorities of the line, in common with those of other lines, are permitted to vary their tariff, specially exclude tunnel charges which are levied in addition. The effect is to rather enhance the charges all round, but this, owing to the financial condition of the line, is unavoidable, and there can be no doubt that as the present loss becomes less and eventually turns into an annually increasing profit, the charges will be correspondingly decreased, to the ultimate greater profit of the system. It may be noted, however, that the total loss to the State on the working of the line during the year 1907 was only Rs. 12,189, a somewhat insignificant sum when the extreme utility of the undertaking is taken into consideration. The construction of the Kalka-Simla Railway is one of the finest of the many fine engineering feats that India can show, it not even being surpassed by the Darjeeling-Himalayan Railway, although the latter represents also a monument to engineering genius. It is, therefore, all the more to be regretted that it has not as yet proved a financial success. The present administration is making great efforts to popularise Simla and other stations on the line and so increase traffic over it. To this end, it has, among other things, got out an extremely interesting and very finely illustrated Guide Book, which, if an expression of opinion may be permitted, is a distinct improvement upon those usually issued by railways in India. Probably the best feature about this book is that information as to trains, the carriage of luggage, etc., is so intermingled with graphic descriptions of the journey from Kalka to Simla, that the whole is eminently readable from one end to the other—a thing that cannot usually be said about the average guide book or coaching tariff.



BAROGH TUNNEL (3,752 FEET LONG) KALKA-SIMLA RAILWAY.

BAROGH STATION, KALKA-SIMLA RAILWAY.

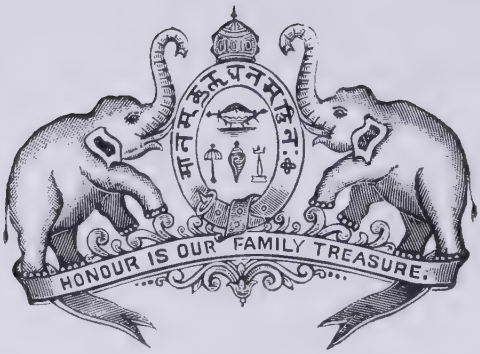
CUTTING NEAR SALOGRA, KALKA-SIMLA RAILWAY.

FOREST AND PLANTATION LIGHT RAILWAYS.

THE COCHIN FOREST STATE TRAMWAY.

THE GOALPARA FOREST TRAMWAY.

THE TEZPORE-BALIPARA LIGHT RAILWAY.



THE

COCHIN GOVERNMENT GAZETTE.

EXTRAORDINARY.

PUBLISHED BY AUTHORITY.

ERNAKULAM :—*Tuesday*, $\frac{\text{Kanni 11, 1081.}}{\text{September 26, 1905.}}$

HIS EXCELLENCY the Right Honourable Arthur Oliver Villiers, *Baron* Ampthill, G. C. S. I., G. C. I. E., Governor of Madras, arrives at Chalakudi by Special Train at 10-30 A.M. on Tuesday, the $\frac{\text{11th Kanni 1081}}{\text{26th September 1905}}$, and proceeds after breakfast to Wellikolangari and thence to Thoppathikamalai after lunch. Halting there for the night His Excellency leaves for Orukombankutty the next morning for breakfast, and reaches Parambikolam in the evening. His Excellency will make a stay of four days there shooting in the State Forests, after which he will return to Chalakudi for breakfast on the morning of Tuesday the $\frac{\text{18th Kanni}}{\text{3rd October}}$. There will be a State Luncheon at 2 P.M. on the same day, and at 3 P.M. His Excellency will, at the request of His Highness the Raja, perform the ceremony of opening the Cochin Forest Tramway. At 6 P.M. His Excellency leaves Chalakudi for Shoranur by Special Train. The arrival on the $\frac{\text{11th Kanni}}{\text{26th September}}$ is private. The departure on the $\frac{\text{18th Kanni}}{\text{3rd October}}$ is public, on which occasion all officers of the State who are on the Darbar list are requested to be present.

Tuesday, the $\frac{\text{18th Kanni}}{\text{3rd October}}$, will be a public holiday throughout the State in honour of the occasion.

Office of the Diwan of Cochin
Camp—Chalakudi.

10th Kanni 1081.
25th September 1905.

By Order,
C. ACHYUTA MENON,
Secretary to the Diwan.

The Cochin Government Gazette Extraordinary which was issued at the time of the opening of the Cochin Forest Tramway.

FOREST AND PLANTATION LIGHT RAILWAYS AND TRAMWAYS.

(1) THE COCHIN FOREST STATE TRAMWAY.

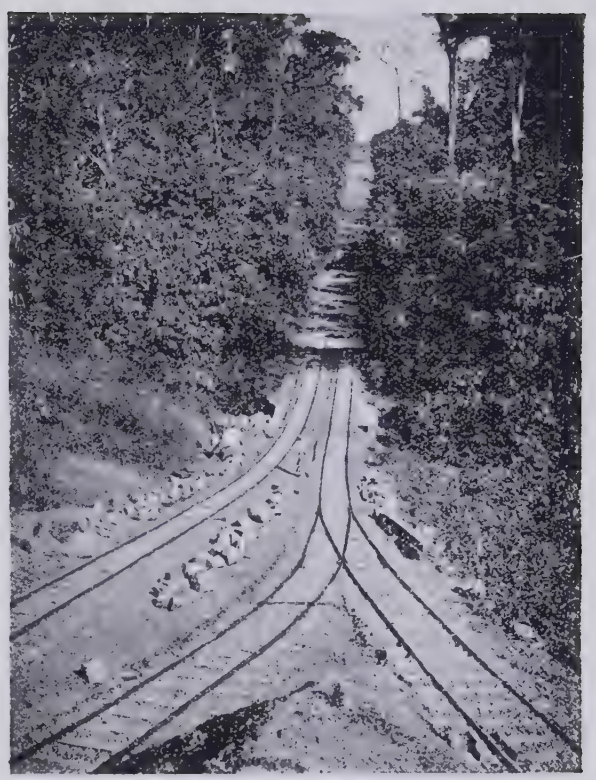
THIS forest line is probably one of the biggest and best equipped tramways designed for purely forest work in the world, and it possesses many features of special interest to engineers, arboriculturists and railwaymen generally.

A line of tramway on the metre gauge, it runs through a portion of the semi-independent State of Cochin in South India, to the north of the 10th parallel of latitude and the east of the 75th parallel of longitude. It owes its origin to the fact that the forests of Cochin form one of the most valuable assets of the State, their total approximate area being 505 square miles or nearly one-half of its entire extent. Their commercial importance was, it is stated, vaguely realised as far back as the beginning of last century, but the earlier attempts to work them were of the usual spasmodic and unsystematic nature which characterized original efforts in forestry throughout the Indian peninsula. In the year 1835, however, a regular Forest Department, under the control of a European officer, was formed and worked for some sixty years on old-fashioned lines. Though the Department, throughout this period, brought in a certain amount of revenue to the State, there was little or no pretence made of administrating the forests on scientific principles, with the more or less natural result that while the interior of the forest area (from which there were no facilities for transporting the cut timber) remained practically untouched, work was confined to the more accessible portions and those from which transport was easy. It was not until the year 1895 that a move for the better was made when suggestions were made by the Resident, Sir James Thomson, which culminated, early in 1897, in the Madras Government placing at the disposal of the Cochin State a British Forest Officer, Mr. Foulkes, for the purposes of inspecting the forests and formulating proposals for their better and more profitable administration. This gentleman's report included the recommendation that the services of a trained

and experienced Forest Officer be obtained, and, acting in accordance with the suggestion, the Cochin Durbar obtained from the Madras Government the loan of Mr. V. Alwar Chetty, T.F.S., for a period of seven years.

Mr. Alwar Chetty assumed charge of the administration of the Cochin Forests in April 1899, and it is related that his first care was to inaugurate a period of rest for the overworked area of timber and to set about securing a suitable outlet for the prospective output of the then virgin forests. In 1900, at the suggestion of Mr. Alwar Chetty, Mr. Hadfield was appointed to co-operate with him as special Forest Engineer, and the preliminary work of these two officers consisted in surveying the Chalakudi River with the object of ascertaining the practicability of utilizing these waters to float down cut timber from the interior. It was found, however, that the higher reaches of the river were so full of obstructions that the cost of training them for this purpose would be prohibitive, while, in any case, the river could only be used for the transport of timber for about four months in the year On the other hand, the inspection disclosed the fact that a land route, provided means of transportation over it were available, would tap a far richer forest area than the river alone did, while, of course, it would be open all the year round. So it came about that the idea of a tramway in three sections arose and was recommended to and sanctioned by the Durbar. The first section was to cover a distance of 8 miles in the valley to be followed by a self-acting inclined tramway 5,000 feet long. The second section, 4½ miles long, was to be followed by a slide 7,000 feet long, whence the third section, also 4½ miles long, was to extend to the Kurumali River, from which point timber could be floated to the railway station at Trichur during the monsoon period and carted to the Chalakudi Station in the dry weather. According to this first propounded scheme, timber from the hitherto unworked Parambikolam Forest was to have been floated by the Parambikolam River to the Tramway Terminus in the Valley. A visit paid by His Highness the Maharaja of Cochin to the Parambikolam and Nelliampatty Forests in October 1903 suggested a revision of this scheme, the revision providing for the extension of the proposed tramway to Parambikolam, an additional 12½ miles, the experience gained during the preceeding year or two having shown conclusively that the Parambikolm River could not be

DOUBLE-RAILED, SELF-ACTING INCLINE WAY, COCHIN FOREST TRAMWAY.



ANOTHER VIEW OF THE SAME INCLINE.

ANOTHER INCLINE, COCHIN FOREST TRAMWAY.

relied upon to carry every year anything like a year's full yield of timber. A survey of this extension was made by Mr. Haldwell, a specially engaged engineer, in 1904.

According to the original scheme, the traction of the timber trucks was to have been by manual labour, but when the length of the proposed line amounted to 31 miles, it was recognised that manual labour would prove both too expensive and too laborious, and in September 1904 locomotive engine traction was finally decided upon The modifications of the original scheme already alluded to necessitated a full reconsideration of other portions of it, chiefly the proposed combined river and road transport which it was anticipated would not clear the accumulations of timber. Also in practical working, it was found that a timber slide, especially in the case of lengthy and heavy logs, was unsatisfactory and the handling of logs both at the head and foot of the slide proved expensive. To remedy this latter, the conversion of the slide into another self-acting incline was decided upon. To remedy the first Mr. Alwar Chetty recommended and and the Durbar sanctioned, another extension of the tramway, one of 15 miles to Chalakudi, to meet the Shoranur-Cochin Railway at that station, a connection, with the acquiescence of the Madras Railway authorities, being made between the railway and tramway there.

To-day the total length of the line as it stands completed at the time of writing is 49½ miles divided into three sections. The first section extends from mile 1 to 21, the second from mile 22½ to 27 and the third from mile 28 to 49½. The first and second sections are connected by a self-acting wirerope manipulated doubleway of 1½ miles, whilst the second and third sections are similarly connected by another incline of a mile in length.

It has been stated that the length of the Cochin Forest State Railway as finally decided upon and constructed is 49½ miles, but it should be added that this length is not inclusive of sidings or sections of double line. The total length including these is 56 miles. The rails utilized between miles 0 to 10 are 28lb flat-footed steel rails, and between 10 and 49½ miles, 21½lb.; in both cases they are laid on sleepers of Teak, Irul, Koramaruthu or Pongu woods of 6 feet by 7 inches by 4½ inches dimensions spaced two feet apart centre to centre, the rails being fixed to the sleepers by

means of ordinary dog spikes, chairs or tie-plates not being used. The gauge is metre, the average gradient of the line 1 in 80 and the maximum gradient 1 in 2·5, which gradient occurs on the third of the five inclines which have been embodied in the construction.

The line starts from Chalakudi Station and runs almost due east to the head of the Parambikolam Valley. From Chalakudi to the 9th mile no gradient exceeds the ruling grade. Between 9 and 10 miles there are two reversing stations, thence the line runs along the Muppli Valley as far as the 19th mile after which there are four reversing stations leading up to the foot of the first incline. The line then rises by three successive inclines and crosses the Pandimudi Ridge, about 1,500 feet below the summit, which is 3,626 feet above sea level. Consequently at this point the height of the rails above sea level is some 2,126 feet. The line then descends by twelve reversing stations to Kothermuzhi, 25 miles, and thence along a slightly rising gradient to Pothupara, 26½ miles, from which it rises by means of two inclines to Komalapara, about 2,500 feet above sea level. It then descends by five reversing stations to Myladappen and again by three more to Muduorachal, 32 miles, from which station it runs along the Karappara River Valley as far as 36½ miles, crosses the Kuriarputti River at 41 miles and continues along the Parambikolam River up to the terminus of the line, which is 2,700 feet above sea level. A number of necessary sidings are provided *en route* to facilitate loading of the various species of timber adjacent to the depôts wherein these are collected after the trees have been felled. The second section of the line, 22 to 27 miles, runs along a deep valley either side of which is bounded by lofty ridges which it crosses by means of the reversing stations and two of the inclines already alluded to. There are nineteen reversing stations in all, ten in the second and nine in the third section and five self-acting inclines. These inclines merit a special description being given of them, as they are practically singular of their kind in India.

The incline-ways referred to are so constructed as to be self-acting, and three of them are situated in series between 21 and 23 miles and the other two between 26½ and 28⅞ miles. They are worked by means of wire cables controlled from brake-houses by gear brakes independent of each other, and consisting of horizontal wheels round which the cables pass two or three times. The inclines are double railed with suitable cross-over points at the

GENERAL VIEW OF A PORTION OF THE MAIN LINE OF THE COCHIN FOREST TRAMWAY.

LOCOMOTIVE, TRUCK AND BRAKE-VAN, COCHIN FOREST TRAMWAY.

A TRAIN OF TRUCKS ON THE COCHIN FOREST TRAMWAY.

up-hill side of each brake-house. The points are so arranged that a descending load, which travels down by force of gravity, requires no up-hill shunting—practically the locomotive places the truck which, on being uncoupled, is then ready for the descent. In some cases, however, empty trucks going up have to be hand shunted after being placed in order to place them on the side of the upper incline on which the traction rope lies The ropes are flexible and are of 1⅛ inch plough steel wire. The cable passes over a grooved pulley 6 feet diameter after which it forms a figure of 8 over a loose pulley, back again over another 6 feet pulley mounted on the same shaft as the first and thence to the other line. On the vertical shaft on which these two pulleys are, and on which the rope binds, are mounted two horizontal drum pulleys each 6 feet diameter, 3½ inches broad with ¼ inch flanges. Steel hand brakes $\frac{3}{16}$th inch thick and 3 inches broad, studded with hardwood brake-blocks 6 inches long, can be applied to these drums by powerful linked levers controlled by hand wheels and screws to control the speed of the load descending the incline. The grooved pulleys round which the rope binds are filled in with leather sections on end-grain to give a good grip. The cast-iron portion of these wheels is suitably dovetailed out to contain the leather packing.

The first, second and fourth of the five incline-ways are on curves, round which curves the wire ropes are guided by vertical rollers. On the straight portion of the inclines the cable is supported by horizontal rollers placed 30 feet apart. Of one of these inclines two illustrations are here reproduced, calculated to convey a good idea of the arrangements just detailed. A third illustration depicts, at closer range, another of the inclines and between the set of rails on the right hand the wire cable can be clearly seen. A fourth illustration gives an excellent general view of a portion of the main line shewing an empty train in course of transit up to the hills to return in due time with a load of felled timber. The incline ways were erected by the firm of Messrs. Orenstein and Koppel (now Messrs. Orenstein and Arthur Koppel), Light Railway Engineers, etc., of Berlin and Calcutta, who also supplied the locomotive stock. The same firm supplied the rails, points, crossings, etc., as also the rolling-stock. The rolling-stock of the Cochin Forest Railway consists solely of open bogie trucks, specially designed for carrying timber, with swivelled bolsters and chilled cast-iron wheels, each bogie having a carrying capacity of 12 tons. The use of the chilled cast-iron wheels is worthy of passing mention in

view of the fact that at the present time their economy or otherwise is a matter of some controversy among railway administrations, the opinion being largely held that the longer initial life of the chilled surface does not compensate for the greater difficulty and expense subsequently attendant on grinding it up. It would, therefore, be interesting to know the opinion of the mechanical authority of the Cochin Tramway with regard to them and to hear how they have worn under the stock of that line. The next two photographs depict a locomotive, truck and brakevan, and a train of trucks in the Forest. The locomotives of the line, which are generally of one type, are designed to pull or push a gross load of thirty tons on a gradient of 1 in 50 or eighteen tons gross on a gradient of 1 in 25. They are built for an ordinary working boiler pressure of 205lbs. per square inch (which will be recognised as well above the ordinary especially where metre gauge or light line engines are concerned) and are fitted with the Orenstein and Koppel patent valve motion, the leading feature in the whole design being a combination of maximum effectiveness with a minimum of simplicity in construction and mechanical motion generally. The leading dimensions of the type are—

Cylinders	8¼″ × 12″
Diameter of wheels	26″
Total Wheelbase	4′-7″
Heating Surface	
Grate Area	4½ sq. feet.
Tubes	204½ sq. feet.
Total	209 sq. feet.
Capacity of tank	245 gallons.
Capacity of bunkers	31½ c. feet.
Weight of engine and tender empty ...	8 tons 3 cwts.
Weight of both in working order ...	10 tons 7 cwts.
Tractive effort with 60% of the cylinder pressure	3,795lbs.

The total expenditure debited in the accounts of the State against the Tramway up to the end of August 1907 was Rs. 15,15,709, while the debited expenditure for the year 1st September 1907 to 31st August 1908 (that is the Hindu year 1083) for both construction and maintenance was Rs. 5,02,016, the grand total of expenditure down to the end of August 1908, therefore, being Rs 20,17,725. This sum includes maintenance charges, cost of rolling stock, etc., etc., but not the value of timber supplied from the forests for construction, an item for which no account is given. It was estimated last year (1908) that

A BRIDGE ON THE COCHIN FOREST TRAMWAY.

A BRIDGE ON THE COCHIN FOREST TRAMWAY.

a further sum of Rs. 91,364, as detailed below, was still required to make the line thoroughly efficient by repairing or replacing temporary bridges and culverts, etc., and supplying sufficient rolling stock :—

	Rs.
Extension	1,831
Bridges and Culverts	34,033
Telephones	5,000
Staff Quarters	16,000
Station Machinery	149
Rolling Stock	34,451
Chains for Rolling Stock	900

The annual cost of maintaining the line, rolling stock, locomotives, etc., etc., is estimated at Rs. 1,20,000.

The next illustrations are views of bridges on the line, while a picture of a clearing in the Forest shows the practice of elephants moving the felled timber and the method of loading this on to trucks by hand crane.

The present terminus of the Cochin Forest State Tramway is in the centre of a depôt where the felled timber is collected. This depôt extends for half a mile beyond the terminus, but the line will eventually be linked up to the end of it. Apart from this short extension, the working of the area of land which contains the bulk of the teakwood in the State up to the British boundary, will entail a further extension of between four and five miles long, the cost of which, it has been estimated, will involve a capital expenditure of a lakh of rupees.

The total area of virgin forest land owned *by the Cochin State* is about 217 square miles, of which 127 miles are tapped by the Tramway. The balance of 90 square miles, comprised mostly by the Sholayar and adjacent valleys, is not yet connected with the outer world by any means of cheap, easy or quick communication. The area tapped by the tram line is officially designed the "Orukomban Working Circle" and is divided into four series known as the A, B, C and D as follows :—

Series.	Timber.	Square miles.	Timber.	Square miles.
A	Deciduous	24	Shola	*nil.*
B	,,	*nil.*	,,	28
C	,,	20	,,	*nil.*
D	,,	32	,,	23
	Total ...	76		51

Teakwood is not found to any really appreciable extent in these series, though there is a total area of about 20 square miles of it in C and D. The tram line runs through almost the middle of this area from its western to its eastern limits, but a river intervenes dividing the area into two, the tramway being on the northern side. As is usual in all Indian forests, the number of species of trees which abound is manifold, but the number of those which can be put to practical use and have therefore a steady market value is extremely limited in comparison. In conclusion, the names of the few valuable marketable species are subjoined, together with remarks as to their economic uses :—

Teak, a decidious species weighing about 40lbs. per cubic foot. A timber which is, as is well known, in the very forefront of Indian woods. It is largely used in railway work for the construction of the bodies of passenger coaches and covered and open goods wagon stock, while it is also used in connection with furniture work and for ornamental carving.

Rosewood is found in both deciduous and shola forests. It is supplied to the Military authorities for the manufacture of gun carriages, while, more widely, it is used for furniture and carving.

Irul, also a deciduous species, is the nearest approach to "Ironwood" to be found in India. Owing to its ability to withstand exposure to climatic influences and immersion in water for a long period it is used for permanent-way sleepers and bridge work. The small quantity of it that is available in this country, however, is an effective bar to its general or extended use. It weighs about 55lbs. to the cubic foot and has a comparatively high tensile strength. It is, in fact, the Indian jarrah.

Venteak occurs in both the deciduous and shola areas and finds its principal outlet in being used for roofing shingles, stakes, packing cases and in house construction.

Koramuthu, a deciduous tree more commonly called the "Malabar Lancewood," is a more useful timber and is in demand for the building of carriages, carts and agricultural implements.

Vengai is a deciduous tree which is identical with the "Padauk" of the Andaman Islands. A good portion of this timber which is felled in the Andamans goes to America where it is used for the building and interior work of railway carriages. In Cochin it yields the commodity known as "Gum-kino."

A CLEARING IN THE FOREST.

Elavu is found in both deciduous and shola areas and is the silk cotton tree.

Pongu is purely a shola tree, with a good, hard, close grain. It is used on a small scale for boat building, sleepers, bridge and mine work, etc.

Ebony is also a shola tree and its uses are of course well known.

White and *Red Cedar* are shola trees the timber of which is largely used for interior panelling, wains-coating, etc., while we are all familiar with it in the shape of a cigar box.

Ivini, *Churli*, *Kolanava*, and *Mylallu* are all shola trees, while *Poovam*, better known as the "Ceylon Oak," is a high class wood. In addition to these, other species of minor importance which are to be found within the forest area of the Cochin State are:—*Nadunar*, *Pyne*, *Thelli*, *Thani* and *Nelli* (that gives the myrabollams of commerce), *Kanjiram* (from the pods of which we get strychnine) and *Kandapulli*.

Much of the foregoing information concerning the Cochin Forest Tramway was supplied by the Diwan of Cochin State, to whose courtesy for this, as also for the photographs which are reproduced here, the writer is indebted.

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(2) THE GOALPARA FOREST TRAMWAY.

PROBABLY no better account of this interesting tramway is extant than that which appeared in the *Indian Forester* in its issues of September and October 1906. The author was Mr. W. F. Perrée, I.F.S, then Conservator of Forests in Assam and now Assistant Inspector General of Forests. Owing to his courteous permission and that of the present Honorary Editor of the *Indian Forester*, Mr. P. H. Clutterback, the information then given is available for reproduction in this volume, and the following pages are *verbatim* extracts from Mr. Perrée's notes:—

"In places where ordinary means of transport are scarce or costly, where the use of carts is possible only for a short season, and where materials in quantity have to be transported in excess of the capability of ordinary local means, tramways may often offer a solution of transport difficulties. The Goalpara forests which are situated

under the Bhutan Himalayas at distances varying from 30 to 60 miles from the Brahmaputra river, have always suffered from insufficient means of export. The resident population has never kept draught cattle for any purpose beyond ploughing, and the transport of timber has been hitherto done by hand, large trees being cut into short logs (dhums) under 7 feet in length which are rolled by hand sometimes for 12 or 15 miles to a floating stream. Smaller timber has been carried out of the forest on men's shoulders. On reaching a suitable stream the timber is lashed to dugouts and taken to the Brahmaputra whence it is rafted with the help of large boats to the principal towns of Eastern and Lower Bengal. It is evident that these extensive forests could not be worked successfully by means of such primitive transport; the inaccessible blocks generally remained untouched and the entire yield was seldom brought to market. The land adjoining the reserved forests is, with the exception of a few Mech villages, almost uninhabited. Local labour is therefore scarce, while the unhealthiness of the Terai tract renders work by imported labour possible only during the short season from December to April. Difficulties are enhanced by the presence of a waterless or "Bhabar" tract varying in width from 8 to 15 miles which is waterless during the open season. Attempts to sink wells have been made, but below 30 feet large boulders are encountered rendering excavation next to impossible and water is not found even at a depth of 80 feet. In deciding on additional means of transport it was therefore necessary to always bear in mind that workmen in the "Bhabar" tract would have to be supplied with water. Elephants are in use for dragging timber and a part of the outturn has been extracted with their help, but these animals are liable to outbreaks of anthrax and are unsuited for work at a distance from water. Buffaloes or bullocks could have been used for draught, but they would have involved the construction of roads for cart traffic which in forests where the rainfall exceeds 150 inches are soon churned into quagmires, and the local cattle are infested with rinderpest and foot-and-mouth disease, so there was clearly great danger in relying solely on horned cattle. After due consideration, it was decided to lay a tramway in the Western Range which is the most remote from the sale depôts and offers the greatest difficulties of transport as well as disadvantages regarding water-supply. The line was commenced from a convenient flowing stream and gradually pushed northwards to deal with the coupes in

succession. Some re-arrangement of coupes was necessary to ensure the most economical use of the tramway. In 1901-02 a commencement was made with 2½ miles, subsequent additions bringing up the total to 9½ miles. The gauge and strength of materials had first to be settled. Portability is an important factor and the universal 24 inch gauge was therefore adopted. In deciding on the strength of materials it was necessary to know the safe loads for rails of different strength. The weight per yard of rails is used to indicate the quantity of metal in the various sections, so that the strength varies with the weight. The safe load is indicated by the maximum pressure which a wheel can carry without causing deduction in the rail and this again varies with the spacing apart of the sleepers.

The following table shows the wheel pressures for different weights of rails with the spacing of sleepers in most general use :—

Sleepers apart.	Wheel pressures for rails of					
	10 lbs. per yard.	14 lbs. per yard.	18 lbs. per yard.	18¼ lbs per yard.	20 lbs. per yard.	24 lbs. per yard.
40″	990	1,700	1,960	2,485	2,900	3,970
36″	1,100	1,900	2,130	2,755	3,210	4,600
32″	1,275	2,150	2,500	3,170	3,685	5,300
27″	1,450	2,510	2,900	3,650	4,230	6,075

These figures are approximate for mild steel and it should be remembered that laboratory tests require a substantial margin of safety. The comparatively large differences between rails of 18 lbs. and 18¼ lbs. is due to the difference in section; the latter is nearly ½ inch taller and while offering greater resistance to vertical pressure is obviously more liable to lateral deflection. It is, however, important to realise that a comparatively light rail may carry the same load as a heavier one, if more closely sleepered, a useful fact to remember in determining the initial outlay. In the present case it was considered that the maximum size of logs which the rails need carry would not exceed 50 cubic feet, allowing 70 lbs. per cubic foot and three such logs per bogie truck on eight wheels, the wheel pressure would be only 1,312lbs., so that 14 lbs. rails would clearly be of sufficient strength, especially as the above maximum load would be very exceptionally carried. In order also to keep the

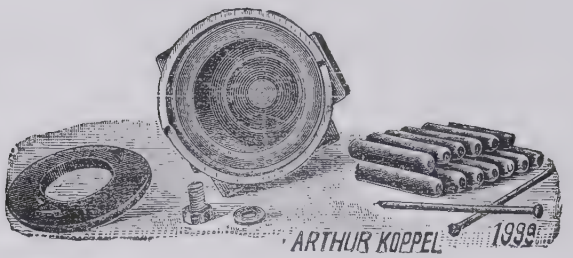
initial expenditure as low as possible, 14 lbs. rails were decided upon, and, with a view to maintaining portability, corrugated steel sleepers weighing about 12 lbs. per yard and 40 inches apart were adopted. It has, however, been proved that on temporary lines where the sleepers do not always rest on a firm bed, it is preferable to place them at about 32 inches interval. This admits of placing sleepers near the rail joints, at which places the rails always show a tendency to bend, especially on gradients where the speed of loaded trucks is considerable. The rails are in 5 metre lengths (16½ feet); the materials were purchased in Calcutta from Messrs. Martin & Co. the then Agents for Messrs. Arthur Koppel & Co. I am greatly obliged to the latter firm for allowing me the use of woodcuts from their illustrated catalogue and for the table of wheel pressures above quoted.

The laying of the line offers no practical difficulty and is easily accomplished by unskilled labour. The ground in the tract here dealt with is generally level with a slight slope from north to south which is the general direction of the alignment. A few undulations and shallow depressions necessitated small embankments in order to keep the slope down to 1 in 200. After selecting the alignment, the trees were felled by the roots to a width of 10 feet, a track 6 feet wide was then raised about a foot above the surrounding level by cutting drains 2 feet wide on either side and throwing the earth on the centre. In high land this is sufficient, but in places liable to inundation the line must always be above flood level. The surface was then approximately levelled by eye and the tramway materials fixed together by a simple system of bolts and nuts. Mech and Santhal coolies were employed. The materials are roughly placed in position and bolted together and the rails are fixed to the sleepers by clips which are bolted through the sleeper. There is a rectangular hole in the sleeper through which the similarly shaped bolt head is passed. The bolt is then turned through 90° and the clip firmly screwed down. The holding is found to remain firm for years. In the last extension of 3½ miles, which it is calculated will remain in position for 6 or 7 years, wooden sleepers ($4\frac{1}{2} \times 5'' \times 4''$) at 33 inches interval have been employed. The cost is very little less per mile than if steel sleepers at 40 inches interval are used owing to the enhanced cost of laying by skilled labour.

The defect in the steel sleeper is that resting on the surface, and the end being open, it does not offer the same resistance to lateral displacement as a wooden sleeper firmly buried to a depth of 4 inches

in a well-trodden earth. Wild elephants walking between the rails kick them outwards as they pass along and displace the line laid on steel sleepers laterally but have no such effect on the section laid over wooden sleepers. After the line has been securely bolted it is straightened with crowbars and packed. For this purpose some earth is thrown on the line from the drains and packed firmly under the sleepers. Ballasting is unnecessary, but good drainage is essential. The laying of curves is a simple matter. As a rule this can be done by eye, remembering always that too steep a curve is apt to cause trucks to derail; on the other hand, it is not advisable to bend more rails than are absolutely necessary, as this may effect the usefulness of materials later on. A jim-crow is applied at intervals of a foot or so along the rail until it reaches the necessary curve. Some practice is required to apply force evenly all along the rail and thereby avoid an uneven curve. Having completed one rail, the other is placed on top of it now and then, as the jim-crow is applied, in order to gauge the progress and thereby ensure exact correspondence of adjoining rails. When lifting the line and relaying it in another place, it is not necessary to open the sleeper bolts at all, the fishplates only need be opened and the line lifted in rail sections. In practice it is found easy to lift the 14lb. plant in sections of two rail lengths. For this purpose the rail joints are kept exactly opposite each other. This is not possible on curves, where the inner rail soon projects beyond the other. The former can be cut or on temporary lines a block of wood may be inserted to fill up the gap. If hard wood is employed and firmly fixed to a wooden sleeper renewal will not be necessary more often than twice a year.

In purchasing rolling stock it was necessary to arrange for trucks which would be suitable for use as bogies for long timber or singly for the transport of short logs and sleepers. It was therefore decided to purchase iron trucks with a removeable bolster. The frames are 6 feet in length and 2 feet 10 inches in width, outside measurements. The upper surface of the frame is 1 foot above the top of the rail and the distance between centres of the wheels is 2 feet. The axle-boxes are of cast-iron and the bearings are of white anti-friction metal. There is great economy in oil and traction by the use of closed axle-boxes with white metal bearings. The latter have been found to last over five years and can be renewed at a cost of one rupee a piece.



PATENT ROLLER BEARING AXLE-BOX USED ON GOALPARA FOREST TRAMWAY STOCK.

Recently an experiment has been made in introducing roller bearings a modification of the well-known ball-bearings, on the trucks used to carry water, the frames of which were made locally. A plate is given which illustrates the axle-box unmounted. The makers claim a saving in traction of up to 50 per cent. by their use, and although this statement has not been tested, the saving in traction is very marked.

It was thought at first that brakes would be necessary, and half the trucks were provided with a powerful screw brake, the handle of which was vertical and was soon found to interfere with the loading of round timber and sleepers. Recently acquired trucks have been fitted with a lever brake which works at the side and can be actuated by a man standing on the load. Gradual improvements of gradients and the regulation of traffic have practically enabled brakes to be dispensed with. Slight undulations of the surface prevent trucks from running any distance at a high speed. It is obvious that curves should, whenever possible, be on the level, so that trucks which may be travelling in opposite directions may not meet at high speed. On the other hand gradients which admit of high speeds should be on straight lengths, so that trucks travelling in an opposite direction can be seen a long way off.

Sleepers and logs form the bulk of the material transported by the tramway. The simplest method of loading is to roll the logs along sloping pieces on to the truck. Where a large quantity of timber has to be dealt with, a sloping platform is erected and the logs placed in position by elephants. Of recent years the yield of the coupes has principally been converted into sleepers. Each truck is fitted with a wooden frame enabling five M.G. sleepers to be laid side by side; the load per truck consists generally of 25 sleepers 37 cubic feet or 24 cwt. Two men can easily push this load

as the gradients are easy. The total charges up to September 1906 on the Goalpara Tramway of 9½ miles have been Rs. 50,976 or Rs. 5,997 per mile. This includes the initial cost of the line and rolling stock of 18 trucks, with transport from Calcutta to the forests, also laying and maintenance. Part of the work of laying and maintenance was done by labour paid in kind, the value of which is not included; on the other hand, the first five miles of line were bought when steel rails were at an abnormally high figure during 1901-02. It may safely be stated that, inclusive of all charges and all labour paid in cash, the present cost of the same plant laid in the forest would not exceed Rs. 6,000 per mile, and this figure may be taken as the maximum cost of a similar tramway in a remote forest.

The Goalpara Tramway has never been used to its utmost capacity; the yield of the coupe has occasionally not been fully exploited, while the difficulty of procuring labour has always been an obstacle to utilization. The labour difficulty is, however, gradually disappearing, and a complete enumeration of the mature stock affords reliable information in making arrangements well in advance.

The following statement compares the actual cost of transporting the outturn of the coupe of 1905-06 with the estimated cost by other means :—

Quantity and kind of produce.	Actual cost of transport by tram.			Estimated cost of transport by cart.		
	Rs.	A.	P.	Rs.	A.	
23,527 M.G. sleepers	1,102	13	2	4,411	5	0
3 sal logs, a distance of 9½ miles .	1	0	0	3	0	0
1,124 scantlings, etc. „ „ ...	17	9	0	35	0	0
51,840 cubic feet of water = 46,650 maunds a distance of 6 miles ...	571	14	0	4,665	0	0
Total ...	1,693	4	2	9,114	5	0

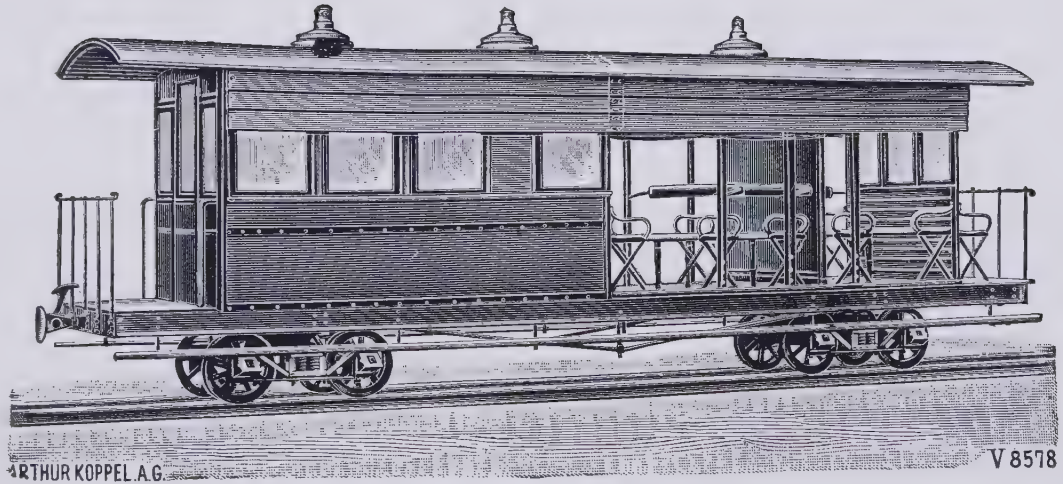
This gives a profit on the tramway of Rs. 7,421-2-10 to which should be added the hire of rolling stock to purchasers, Rs. 136-8-0, making a total of Rs. 7,557-10-10, equivalent to 14·8 per cent. on the gross outlay. Interest charges and deterioration are not included,

The figures are worthy of some little study. It will be seen that the total capital outlay on the system down to the end of the year 1907 was only Rs. 4,87,240, practically Rs. 24,362 per mile of open line, if the fraction of ·10 of a mile be eliminated, not by any means an excessive amount taken in conjunction with the amount of traffic carried and the earnings. Yet, in spite of this and of the fact that the line received a subsidy from the Local Board of Rs. 5,000, the gross return on the investment only amounted to 6·96 per cent. As it is clear the concern is not by any means over-capitalized, the explanation of the comparatively low rate of net interest being earned must be sought elsewhere, and a glance at the proportion of expenses to earnings shew where this is to be found. During 1907 the proportion of expenses to earnings was no less than 74·05 per cent, while this figure, as will be seen, is a fairly constant one, only once having gone below 70 or up to 80 within the last ten years. The circumstances attendant on working are no doubt such as do not permit of the proportion being lowered.

Statistics with regard to the line show that the number of passengers it carries is steadily increasing year by year, while the tonnage of freight hauled has risen rapidly also. The following figures are illustrative of this :—

Year.	Number of passengers carried.	Quantity of goods and minerals carried.
1903 ...	145,000 ...	9,000 tons.
1904 ...	149,000 ...	8,000 ,,
1905 ...	155,000 ...	14,000 ,,
1906 ...	156,000 ...	16,000 ,,
1907 ...	157,000 ...	15,000 ,,

The line cannot perhaps be described with absolute accuracy as a plantation railway but the *raison d'être* of its existence appears to be the serving of tea gardens, and the principal commodity carried is tea, but there is also a varied general traffic which contributes largely to the earnings as the subjoined table



SEMI-ENCLOSED PASSENGER CAR, TEZPORE-BALIPARA LIGHT RAILWAY.

of commodities carried and receipts for each during the year 1907 shows :—

Commodity.	Number of tons carried.	Earnings. Rs.
Coal and Coke	3,105	8,149
Cotton	20	147
Medicinal preparations	12	88
Oil-cake	410	1,031
Gram and pulse	305	1,321
Rice in the husk.	1,073	5,071
Wines and spirits (including country liquor)	19	120
Unwrought iron and steel.	16	96
Chalk and Lime	76	207
Cocoanut Oil	50	342
Oil Seeds	28	233
Provisions	25	137
Sleepers and keys	75	436
Salt	12	94
Sugar	5	27
Tea	4,203	29,243
Mixed articles of merchandise	5,718	15,471

These commodities and figures have been detailed with the intention of showing how many and varied are the items which, in small quantities, go to make up the bulk of ordinary light railway traffic and light railway earnings. The tonnage of the majority of the items set forth is small almost to the point of insignificance, but the earnings, on the whole, are sufficient to provide a return on the money invested in constructing, equipping and operating the line. It is on the receipts for the carriage of many small consignments that light railways fatten and grow rich in their time.

The illustration which accompanies is of a semi-enclosed passenger carriage, with seating capacity for twenty-eight persons, intended for locomotive traction, which was supplied to the line by Messrs. Orenstein and Arthur Koppel & Co. of Calcutta.

THE BENGAL-NAGPUR RAILWAY SPECIAL GAUGE LINES.

THE JUBBULPORE-GONDIA EXTENSION.
THE PURULIA-RANCHI BRANCH.
THE RAIPUR-DHAMTARI BRANCH.
THE GONDIA-CHANDA EXTENSION.
THE MOURBHANJ STATE RAILWAY.
THE PARLAKIMEDI LIGHT RAILWAY.

THE BENGAL-NAGPUR RAILWAY SPECIAL GAUGE LINES.

MENTION has already been made of the network of light railways and rail communications which the Bengal-Nagpur Railway Company is spreading throughout that portion of the Central Provinces which the system serves. These lines are playing and are destined to play an important part in the developement of a province that is rich in agricultural, mineral and industrial possibilities. The possibilities of a remunerative and continuous traffic resultant on the development of Central India through the medium of a number of light railways laid through judiciously selected areas of the province were recognised many years ago and it is now some ten years since a complete scheme for the construction of such lines was first formulated, largely through the instrumentality of Sir T. R. Wynne, then Agent of the Bengal-Nagpur Railway and now President of the Railway Board, under whose personal supervision the scheme was initiated and a portion of the lines it provided for surveyed and constructed. While there can be no question but that the traffic authorities of other trunk railways serving the Central Provinces were alive to the possibilities contained in the laying of light lines to serve certain districts and to act as feeders to their main systems, the Bengal-Nagpur Railway authorities were not only alive to the same conditions, but they were lucky enough to be in possession of, or to be able to raise, sufficient funds to give force to their convictions. The result is apparent to-day in the Jubbulpore-Gondia, Gondia-Chanda, Satpura, Raipur-Dhamtari, Purulia-Ranchi, and, further south, the Mourbhanj State and Parlakimedi Light Railways, all on the 2′ 6″ gauge. With the amount of money employed, more than double the extent of country has been opened out than could have been had the same sum been expended in the construction of 5′-6″ gauge lines. The 2′ 6″ gauge lines introduced into the Central Provinces by the Bengal-Nagpur Railway have, generally, been constructed at a cost of under Rs. 50,000 (approximately £3,333 sterling) per mile, while on Ghaut sections, where broad-gauge construction would have been attended by absolutely prohibitive expense, the narrow gauge has been constructed at less than half the cost, largely owing to the sharper curvature which is permissible.

Mr. Manson, the Agent of the line, in a speech delivered on the 9th of November 1908 on the occasion of the opening of the

Gondia-Chanda Branch, when describing the policy of his Company generally with regard to light railways stated "These 2′ 6″ gauge lines as now made by the Bengal-Nagpur Railway with 40lb. rails and rolling stock designed for 6-ton axle loads, which permit of bogie vehicles carrying a load of 16 tons, can deal with a very large amount of traffic indeed. During the last twelve months (approximately November 1907 to November 1908) the Satpura Railway has not been fortunate in having a very heavy grain traffic on account of the failure of the 1907 monsoon, but it is carrying a heavy coal traffic from the Pench Valley coal fields, and when I say that in a year such as the one now drawing to a close (1908) it has carried 1,325 tons of goods and 2,638 passengers per mile of line, it appears in a not unfavourable light in comparison with many metre-gauge and a few broad-gauge undertakings. I am glad to think that the 2′ 6″ gauge extensions are likely to continue, and we are within the next couple of months going to open an extension from Neinpur to Mandla, 26 miles in length, and I hope before many years are over, sanction will be accorded to construct an extension of this line to Bilaspur, a distance of 153 miles, so opening up the Banjav Valley and the rich plains round Kawardih-Mungeli. On that section a difficult ghaut has to be faced, but surveys that have been made prove that the difficulties are not insurmountable, and that the line can be built though at a cost somewhat higher than the cost of the Satpura or of the Gondia-Chanda. I am also glad to think that, in all probability, sanction will be accorded to another very important extension of this 2′ 6″ gauge system, *viz.*, the construction by the Bengal-Nagpur Railway of the Nagpur-Chindwara line on which I hope work will be commenced early next official year (1909-1910)". The words indicated have been reproduced verbatim as they shew the progressive policy of the Bengal-Nagpur Railway Company so far as giving effect to its belief in the utility and ultimate financial success of light railways is concerned. We may now pass to a brief description of the lines themselves.

(1) THE JUBBULPORE-GONDIA EXTENSION.

This 2′ 6″ gauge line which, as its name implies, connects the two large towns of Jubbulpore and Gondia in the Central Provinces, has an open mileage of about 284·85 miles, which figure includes a branch known as the Neinpur-Mandla, a length which was opened

LOCOMOTIVE, RAIPUR-DHAMTARI BRANCH, BENGAL NAGPUR RAILWAY.

BOGIE HORSE-BOX, PURULIA-RANCHI BRANCH, 2′-6″ GAUGE, BENGAL-NAGPUR RAILWAY.

to traffic on the 15th of February 1909. The mileage given represents about 140·94 miles of main line (Jubbulpore to Gondia) and 143·91 miles of branches, inclusive of course of the Neinpur-Mandla already referred to. The construction of the line by the Bengal-Nagpur Railway was sanctioned in 1901 and it was opened in July 1904, forming an integral portion of the Bengal-Nagpur Railway and being worked by the company under existing contracts relating to the railway generally. The line is ballasted with stone except on a length between the stations of Seoni and Chindwara where black basalt, obtained locally, has been used. The permanent-way consists of 41lb. flat-footed steel rails on sâlwood sleepers, while the ruling gradient is 1 in 80 and the sharpest curve one of 409 feet radius. The traffic earnings and statistics of working of the line are given further on in a table which includes those of the Purulia-Ranchi and Raipur-Dhamtari branches also.

(2) THE PURULIA-RANCHI BRANCH.

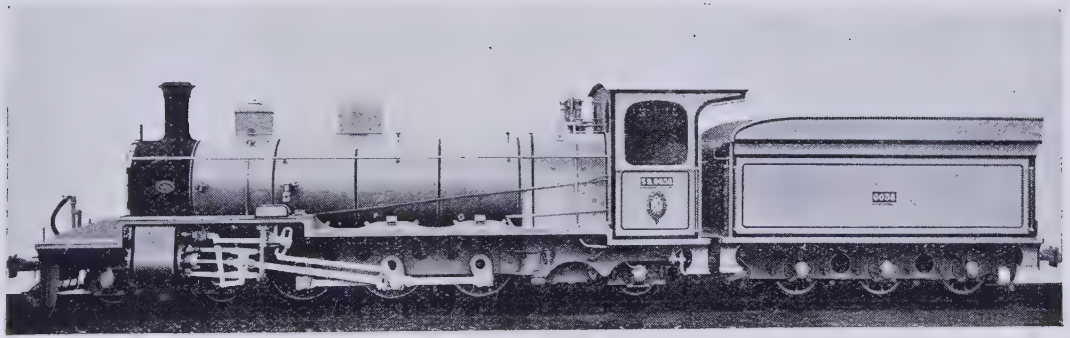
ALTHOUGH only opened to traffic in 1907, this branch has proved a distinct financial success from the commencement, and it bids fair to develope into one of the most useful projects of its kind in the country. Connecting as it does the lower lying country through which the trunk line of the Bengal-Nagpur Railway runs with the tableland upon which Ranchi is situated, it is only 72·45 miles in length but its gross earnings during the half-year ended the 30th of June 1908 amounted to no less than Rs.1,94,570 or an average of Rs. 102 per open mile per week, a result which many other and far older established systems in India would consider themselves exceedingly fortunate in attaining. It is noteworthy also that the line was, to a certain extent, constructed to serve an area subjected to periodical famines, and conditions practically allied to famine were prevalent within this area, during the first period of the line's working. A heavy inward grain traffic was carried, which was largely instrumental in bringing about the gratifying financial results already alluded to (albeit the grain travelled at a specially quoted low rate) and enabled the line to justify its existence and prove its utility at an early date. At the same time, a comment made by Sir Samuel Hoare, the Chairman of the Bengal-Nagpur Railway, in his speech to the shareholders at their forty-fourth annual meeting, shews that it is not at all anticipated that a successful agricultural season within the

area will affect the earnings of the branch, as the country itself, in favorable seasons, grows vast quantities of grain, and people will then instead of importing it, export it, while there will also be a fair traffic in oil-seed, it being calculated that these two combined will, if anything, more than recoup the necessary loss of the inwards traffic. The line is laid with 40lb. flat-footed steel rails on transverse sleepers of indigenous woods, and is ballasted throughout with stone and gravel. The ruling gradient is 1 in 80, and the sharpest curve one of 955 feet radius. Certain working statistics are included in the table given further on.

(3) THE RAIPUR-DHAMTARI BRANCH.

THIS is a 2′ 6″ gauge feeder line the construction of which was sanctioned in 1897, it being opened to traffic in September 1900. It takes off from the Bengal-Nagpur Railway at Raipur and runs a distance of 45·74 miles to Dhamtari, throwing off a branch, eighteen miles from Raipur at Abhanpur, which runs 11·20 miles to Rajim. One mixed train runs daily each way between Raipur and Dhamtari and one each way between Raipur and Rajim. The line is laid with 31lb. flat-footed steel rails on Sâlwood sleepers being ballasted with *moorum* or sand, and stone in a few of the cuttings. The sharpest curve, one of 409 feet radius, occurs at Raipur station, and the ruling gradient is 1 in 200. The following table shews the rolling stock in use and an illustration of one of the locomotives is reproduced on the opposite page :—

Description.	Total number on line.	Maker's name.
Tender Engines	4	Manning, Wardle and Company
Composite first and second class passenger coaches	2	Underframes built by the Leeds Forge Company, and bodies built in the Nagpur Shops.
Third class	14	
Combined third class and brake-van	3	
Covered Goods wagons (four wheelers)	20	Underframes built by the Leeds Forge Company, and bodies built in the Nagpur Shops.
Open goods wagons (four wheelers)	30	
Open bogie goods wagons ...	25	
Brake-Vans	3	



LOCOMOTIVE, GONDIA-CHANDA EXTENSION.

COMPOSITE CARRIAGE, GONDIA-CHANDA EXTENSION.

It may be mentioned that it has been the practice on the Bengal-Nagpur Railway to import the underframes and wheels of their special gauge stock and build the bodies upon these in their own workshops at Khargpur or Nagpur.

The following table of working statistics shews the earnings and the proportion of these to working expenses of the three lines combined, the Jubbulpure-Gondia Extension and the Purulia-Ranchi and Raipur-Dhamtari Branches :—

Year.	Earnings per mile per week.	Percentage of expenses to earnings	Year.	Earnings per mile per week.	Percentage of expenses to earnings.
1901	Rs. 25	72·13	1905	Rs. 42	71·83
1902	,, 21	77·27	1906	,, 56	65·56
1903	,, 21	61·98	1907	,, 72	61·31
1904	,, 31	67·32			

The heavy and noticeable rise in earnings in 1907 was largely attributable to the contribution of the Purulia-Ranchi Railway, which was opened in that year, and the earnings of which from the date of opening to the end of the year are included in the figures. The earnings of Rs. 56 per mile per week in 1906 for the other two lines shew however that they also had begun to find their footing by that year, and the receipts have been rising steadily since.

(4) THE GONDIA-CHANDA EXTENSION.

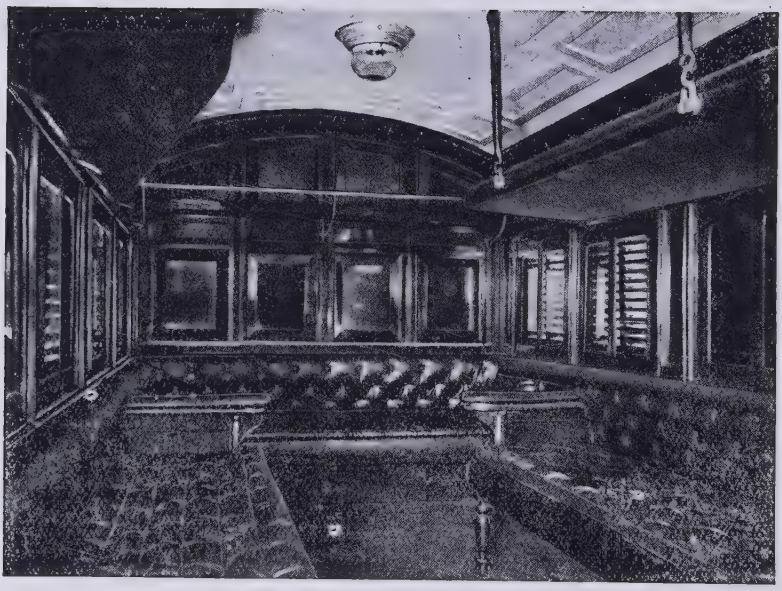
This extension is an integral portion of the Bengal-Nagpur Railway famine lines in the Central Provinces, together with the Jubbulpore-Gondia and the Gondia-Nagbhir-Nagpur sections, and the Nagpur-Chhindwara line the construction of which has just been started. The extension, which runs from Gondia to Chanda (148·65 miles) with a branch from Nagbhir to Nagpur (63·75 miles) was sanctioned in 1904, work was started in November 1905 and it was opened to traffic in November 1908, the opening being made the occasion of a ceremony at which the Commissioner of the Central Provinces presided and the Agent, Traffic Manager and other officers of the Bengal-Nagpur Railway were present together with representatives of the commercial and agricultural communities in Bengal and the Central Provinces, and of the Press. The construction of

the Gondia-Nagbhir-Nagpur extension was, as already stated, commenced in November 1905 and of the section Nagbhir to Chanda in October 1906, but on account of shortness of funds and the large sums required by the main line for new rolling stock, it was found necessary in May 1907 to partially close down the construction of the Chanda section, only proceeding slowly with the first 30 miles from Nagbhir towards Chanda, and to complete the Gondia-Nagbhir-Nagpur section just referred to. The permanent-way consists of 40lb. flat-footed steel rails laid on Sâlwood sleepers $5' \times 7'' \times 4''$ of which there are 2,288 to the mile. The maximum gradient is 1 in 100 and the maximum radius of curve 955 feet. It will, when the scheme is entirely completed, open out nearly twelve thousand square miles of country, and is specially designed to facilitate settlement on tracts of land within this area and to protect the inhabitants in time of famine. That it will do this, there can be no question, also that it will ultimately prove a financial success, though it is, necessarily, too early yet to be able to judge conclusively of its traffic possibilities. Still, the whole scheme was planned by skilled engineers and traffic officers guided by Sir T. R. Wynne and the present prospects unquestionably justify the optimistic views which led to construction work being undertaken.

All the rolling stock is built on four-wheel bogies, and is fully vacuum braked. Considering the limitation of gauge, it compares not unfavourably with much of the metre gauge stock that is at present running in this country. The locomotive equipment consists of nine six wheel coupled tender engines, an illustration of one being given. The coupled wheels are preceded by a four-wheel bogie, while the weight of the firebox and back framing is carried on a trailing bissel truck. The diameter of the coupled wheels is $3' 6''$ and the cylinders, placed outside the frame, measure $14\frac{1}{2}''$ in diameter and have a piston stroke of $18''$. The working boiler pressure is 160lbs. per square inch, the grate area is 17·5 square feet and the total heating surface 1,039 square feet. The tender is carried on six wheels and has a capacity for 1,700 gallons of water and 3 tons of coal. The total weight of the engine and tender in working order is 51 tons 12 cwts, the total length over buffers $49' 4''$, and the tractive force at 90 per cent. cylinder pressure 12,974lbs. The coaching stock, of which illustrations accompany, is all of the very best type, embodying recent practice, and calls for special attention. All the passenger carriages are fully vacuum braked, lighted with Pintsch's incandescent gas, and

COMPOSITE CARRIAGE, GONDIA-CHANDA EXTENSION.

THIRD CLASS CARRIAGE, GONDIA-CHANDA EXTENSION.



INTERIOR OF FIRST-CLASS CARRIAGE, GONDIA-CHANDA EXTENSION

passenger communication apparatus operating on the vacuum brake is provided. The underframes of all classes of the coaching stock are 29′ 6″ long, with centres of bogies spaced 20 feet apart, the bogie wheelbase being 4′-9″ and the length of the carriages, in each case, 32′-10½″ over buffers. The first and second class composite carriages four in number, are replete with every convenience for comfortable travel. Each carriage has accommodation for twelve first class and twelve second class passengers. The ceilings are of millboard painted white, and a pleasing effect has been secured by the introduction of strips of metal worked into various geometrical designs. In addition to the four first and second class composite coaches, there are in use eighteen third class bogie carriages with a seating capacity for 42 passengers each; seven bogie composite intermediate and third class with a capacity for 16 and 21 passengers respectively; six composite postal, luggage and brake vans; eight composite third class luggage and brake vans with a capacity for 8 passengers and 2 tons luggage; and two horse-boxes with a capacity for 4 horses and eight attendants.

The entire goods stock is carried on bogies and is also fully vacuum-braked. The underframes are 29′ 6″ long, with 20′ 9″ between the centres of bogies, the latter having a 4′ 3″ wheelbase. The following are the particulars of the wagon stock in use with figures relative to the various capacities :—

One Hundred and Twenty Covered Goods Wagons :

Tare of each ...	... 6 tons.	14 cwts.
Carrying capacity of each	... 17 ,,	6 ,,
Gross load of each	... 24 ,,	0 ,,

Fifty Eight Open Goods Wagons :

Tare of each ...	... 6 tons.	1 cwt.
Carrying capacity of each	... 17 ,,	19 ,,
Gross load of each	... 24 ,,	0 ,,

Eight Timber Trucks :

Tare of each ...	... 5 tons	15 cwts.
Carrying capacity of each	... 18 ,,	5 ,,
Gross load of each	... 24 ,,	0 ,,

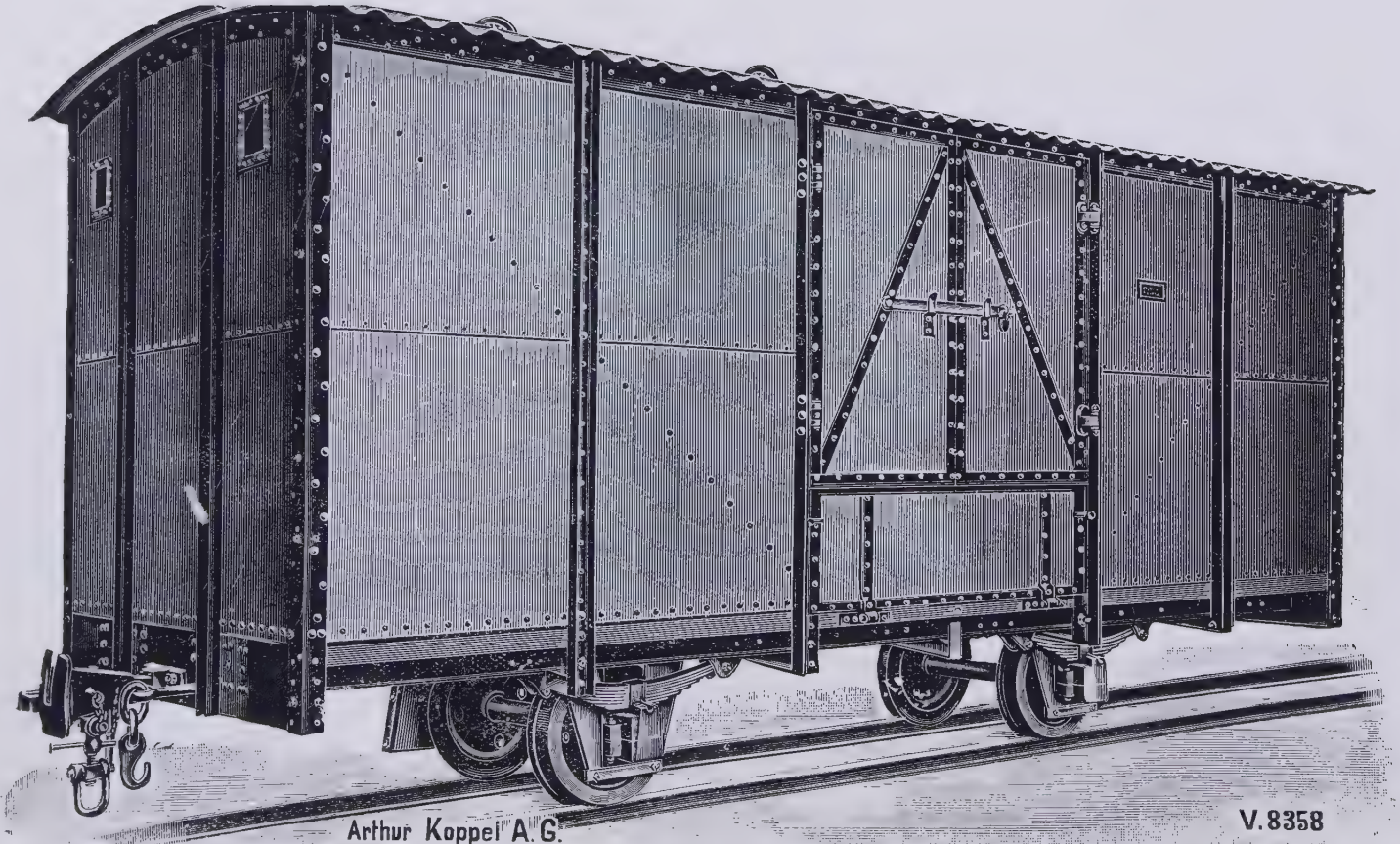
Two Bulk Oil Vans :

Tare of each ...	... 10 tons.	4 cwts
Carrying capacity of each	... 13 ,,	16 ,,
Gross load of each	... 24 ,,	0 ,,

The carrying capacity in proportion to the tare is, it will be noticed, high, when it is recollected that it is 2′6″ gauge stock that is being described, but at the same time, it is stock in connection with the manufacture of which no reasonable expense has been spared in the endeavour to secure the best possible constructional features and results, such features and results, of course, embodying a relatively high tare.

(5) THE MOURBHANJ STATE RAILWAY.

Although worked under agreement by the Bengal-Nagpur Railway Company this line is the property of and was constructed by the Maharaja of Mourbhanj, a semi-dependent chief whose territory lies within the traffic area served by the Bengal-Nagpur Railway. Its construction was sanctioned in the year 1902 and the 32·41 miles of its length were opened to traffic in March 1905. The permanent-way is laid with 31lbs. flat-footed steel rails on Sâlwood sleepers and is ballasted with screened laterite gravel and broken laterite. The sharpest curve is 955 feet radius and the ruling gradient 1 in 100. The Agreement already referred to provides for the Bengal-Nagpur Railway working the line for actual out-of-pocket expenses only and is terminable on the 31st of December of any year on three months' previous notice being given by either side, the rates and fares being fixed by the Company. With regard to this, the natural question arises as to why the Company should work a length of line which is not its property without receiving any remuneration. The reply is, that the smaller line forms a feeder to the larger, carrying to it traffic which it might not otherwise receive, through stimulating trade, agriculture and development generally throughout the area it serves and while it costs the Company nothing to work the line, they calculate upon an increase in the volume of traffic received by their own system, which, of course, means larger financial returns. The scale of passenger fares in force provides for the levying of 18 pies per mile from first class passengers, 9 pies per mile from second class, 4½ pies per mile from intermediate class and 2½ pies per mile from third class. The charge for a special train is Rs. 2-0 per mile in addition to the ordinary fares for the passengers that can be conveyed in the carriages forming the train and freight for all luggage carried, subject to a minimum of Rs. 50-0. The parcels rate for through-booking runs from two annas to eight annas



Arthur Koppel A.G.

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according to weight, with the measurement provision that one cubic foot shall be considered the equivalent of 5 seers, and the restriction that parcels exceeding 5 maunds in weight or $4' \times 3' \times 2\frac{1}{2}'$ in dimension must be booked by goods train at goods rates. The total capital outlay on the line up to the end of 1907 was Rs. 7,12,765, the net earnings during the same year serving to give a return of 3·03 per cent. upon this, not a large interest certainly, but amply sufficient to shew that, financially at any rate, the construction of the line has been justified, while its presence has undoubtedly conferred enormous indirect benefit upon the State.

The following table gives statistics of working from the date of the opening of the branch down to the end of 1907 :—

Year.	Total Capital outlay.	Gross earnings.	Net earnings.	Percentage of net earnings on total capital outlay.	Earnings per mile per week.	Per cent. of working expenses to earnings.
	Rs.	Rs.	Rs.		Rs.	
1905	6,29,160	31,494	9,444	1·50	19	70·01
1906	6,76,547	44,825	21,888	3·24	27	51·17
1907	7,12,765	43,532	21,567	3·03	26	50·46

The gradual decrease in the working expenses as the line got on its feet, so to speak, is worth noticing, and despite the somewhat large capital outlay, in comparison with the gross earnings, the working expenses will probably still further decrease and allow higher interest on the expenditure.

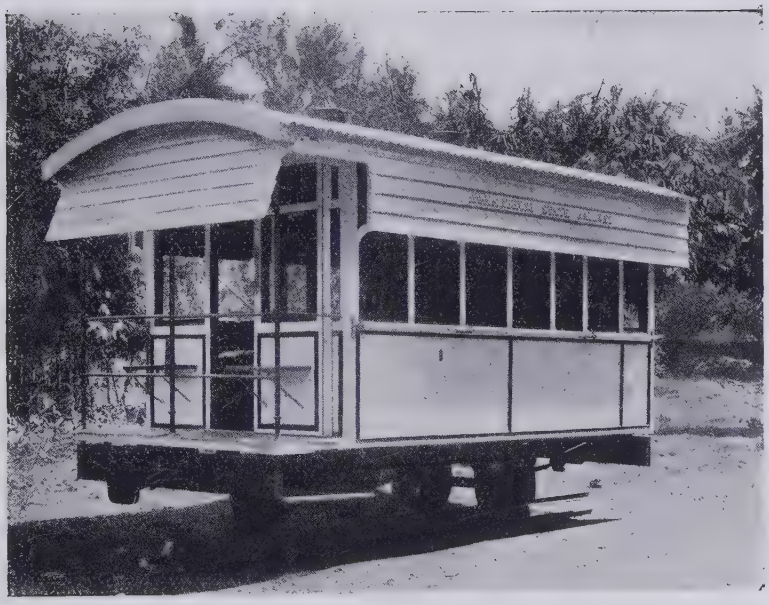
The Mourbhanj State Railway takes off from the East Coast Section of the Bengal-Nagpur Railway at Rupsa Junction mile 133 from Howrah, and runs to Baripada, with seven intervening stations. One mixed train runs each way a day, principally for intermediate and third class passengers and for goods. First class carriages are not attached unless previous notice is given to the authorities at one end or the other that there are first class passengers desirous of travelling. The Maharaja of Mourbhanj, as is usual with Indian potentates, has his own special saloon which is attached and detached to meet his convenience.

The three accompanying illustrations give an idea of the rolling stock employed which was supplied by Messrs. Arthur Koppel and

Company of Calcutta. The first shews a four-wheeled covered goods wagon built entirely of steel with a corrugated iron roof and fitted with side doors, centre spring buffers, screw couplings, safety chains and heavy spring axleboxes. The length over body is 18 feet and the carrying capacity 8 tons, considerably lower, it may be noted, than that of the covered wagons employed on the Gondia-Chanda Railway. The second reproduction is that of a first class passenger coach, the body of which is teak, the length of frame 12′ 6″, the width 6′ 10″, with end entrance and lavatory. The third picture illustrates a combined brake, luggage and postal van, supplied like the other stock by Messrs. Arthur Koppel and Company, the length of the frame being 18 feet.

(6) THE PARLAKIMEDI LIGHT RAILWAY.

This line, like the one just described, is not the property of the Bengal-Nagpur Railway Company who only work it for actual out-of-pocket expenses on behalf of the owner, the Raja of Parlakimedi, under an Agreement dated the 24th of January 1905 which is terminable on the 31st of December of any year subject to three months' notice being given by either side. Its construction was sanctioned in the year 1899 and it was opened in 1900 and taken over, for working purposes, by the Bengal-Nagpur Railway Company in 1902. It is 25·62 miles long and takes off from the East Coast Section of the Bengal-Nagpur Railway at Naupada Junction, mile 437 from Howrah, running from there, with eleven intervening road-side-stations, to Parlakimedi. The permanent-way is laid with 31lbs. flat-footed steel rails on transverse sleepers of indigenous woods and is ballasted throughout with laterite, gravel and stone. There are no curves of less than 1,000 feet radius and the ruling gradient is 1 in 100. The rates and fares are fixed by the Company and the scale now in force with regard to the latter provides for Upper Class (corresponding to first and second class) passengers being charged 18 pies per mile, Lower Class (corresponding with intermediate) passengers 4½ pies per mile, and Lowest Class (third) passengers 1½ pies per mile. The nomenclature, Upper, Lower and Lowest, is distinctly interesting as it is a radical departure, the only one the writer knows of in India, from the customary terms, First, Second, Intermediate and Third. Special trains are charged for at the rate of Rs. 4 per mile plus the ordinary Upper Class fare for each passenger.



FIRST CLASS PASSENGER COACH, MOURBHANJ STATE RAILWAY.

COMPOSITE BRAKE, LUGGAGE AND POSTAL VAN, MOURBHANJ STATE RAILWAY.

From a financial point of view the Parlakimedi Light Railway has, most unfortunately, not been anything like a success, working results of one year only (1905) having shewn even the smallest of returns on the capital outlay without taking into account fixed interest on the sum invested. The statistics of working given below are worthy of some attention and are distinctly instructive :—

Year.	Total capital outlay.	Gross earnings.	Net earnings.	Percentage of net earnings on total capital outlay.	Earnings per mile per week.	Percentage of expenses to earnings.
	Rs.	Rs.	Rs.		Rs.	
1903	7,10,974	16,633	—9,267	.....	13	155·70
1904	7,10,974	20,675	—1,301	.....	16	106·29
1905	7,12,466	27,181	+4,479	0·63	21	83·52
1906	7,12,466	21,494	—9,702	.....	17	145·14
1907	7,12,602	25,440	—5,877	.....	20	123·11

Let us examine these figures closely and see what they reveal. The Parlakimedi Light Railway is, roughly, 24½ miles in length. The Mourbhanj State Railway, already described, is practically 32½ miles in length. The capital outlay on the former has been Rs. 7,12,602 or Rs. 28,944·02 per mile of open line. The capital outlay on the latter has been approximately the same, Rs. 7,12,765, but this gives an expenditure of Rs. 21,931·25 per mile of open line. Beside Mr. Manson's estimate of Rs. 50,000 per mile for building and equipping a light railway for traffic, both those amounts are insignificant, but circumstances considerably alter cases and where an expenditure of Rs. 50,000 would be fully justified by traffic prospects on one line, an expenditure of half that amount would not be justified by traffic prospects on another line. So it has been with the Parlakimedi Light Railway—the outlay per mile and the total capital outlay have not been justified by traffic returns, and it is the Rs. 7,000 per mile more than the cost per mile of the Mourbhanj State Railway that has been expended that has over-capatalized it in comparison with its traffic earnings. Over-capilalization is the one thing a light railway in this country or in any other cannot stand. Taking a strictly utilitarian point of view, if a line cannot be built and equipped in every respect for operations at a cost which will, even eventually, admit of its earnings returning

interest on the outlay, then it should not be built at all. The Parlakimedi Light Railway has been built at a cost which does not admit of its earnings, comparatively good as they are for the 2′ 6″ gauge, returning even a small interest on the outlay. The financier would, therefore, tell you that its construction has been a huge mistake and that as a business concern it is a total failure. Possibly this is so, but the line serves a purpose other than of bringing financial profit to its promotor, a purpose beside which the small amount he is out-of-pocket annually is inconsiderable. It runs through an area which is at no time a heavy grain producing country and is notoriously subject to recurrent famines. It is practically the only means of bringing assistance without delay to inhabitants of this area, the subjects of the Raja who owns the line, and while he would no doubt prefer to be the proprietor of a remunerative concern, he is doubtless content to know that at no large amount of annual expense to himself, his people are placed in a position of comparative security in famine times. Also, the yearly deficit is made good by the State out of the taxes it gathers from the people, these latter, therefore, are, in reality, themselves paying for the benefit they derive from the presence of the railway.

While, therefore, the Parlakimedi Light Railway is not a success financially, and probably never will be, it serves a distinctly useful purpose and is unquestionably justifying its existence.

Of the light lines owned and worked or worked only by the Bengal-Nagpur Railway Company, those which have been described in the foregoing pages are probably the most important, and limitations of space unfortunately preclude the mention and description of others which are equally interesting objects for comment and study.

MINE TRAMWAYS.

THE GANGPUR LIGHT RAILWAY.

THE TUMSARROAD-KATANGI LIGHT RAILWAY

THE BALASORE-NILGIRI LIGHT RAILWAY.

CRABB NULLA BRIDGE, GANGPUR LIGHT RAILWAY.

MINE TRAMWAYS.

(1) THE GANGPUR LIGHT RAILWAY.

THIS light railway, built for the specific purpose of opening out the already partially worked rich manganese ore deposits in the Feudatory State of Gangpur, has a length of 8 miles, including sidings, on the 2 feet gauge.

The company which was formed to raise the capital required for the construction of the line was registered in Calcutta under the Indian Companies' Act in May 1908, sanction to the construction of the tramway was accorded by the Government shortly after, work was started on the 12th June 1908 and the first construction train reached the Ghuriajhor manganese mines on the 8th January 1909—the work done in the short space of time indicated forming very nearly a record in the history of light railway construction in India. The line was inaugurated on the 31st January 1909 with a most successful function, when Mr. Connelly, the Dewan of the Gangpur Feudatory State, declared it open and the first full train load of manganese ore was despatched from the Ghuriajhor Mines to the Bengal-Nagpur Railway for transhipment and onward despatch for export. The Directors of the Company, the Honourable Mr. Basu and Mr. Isaac Shrager, were present on the occasion and in the course of an interesting speech the latter gentleman, who is the Managing Director of the concern, with whom the idea of the line originated and to whose energy its successful completion is largely due, described and eulogised the business-like manner in which the Bengal-Nagpur Railway Company and the Feudatory Chief and Dewan of the Gangpur State had afforded the enterprise every possible assistance it lay in their power to give.

The line connects with the Bengal-Nagpur Railway at Dhuruadihi, 320 odd miles from Howrah, running thence to the Ghuriadhor Mines which are largely the property of Babu Madhu Lal Doogar and which are now in full working order.

The road is of a six foot formation on banks and cuttings, the average slope of earthwork being 1 in 1¾. Exclusive of two timber bridges at mile 1 and Crabb Nulla Bridge at mile 6 (of which an illustration is given in these pages), the drainage works are of boulder banks. A temporary bridge, made of timber cribs supporting 75lb. double-headed steel rails and 20lb. steel rail cluster girders, crosses the Sampai River. The permanent way consists of 20lb. section steel rails laid on indigenous timber sleepers spaced 2 feet 5 inches apart. For the present, tractive power is provided by three 6-wheel coupled tank locomotives of 40 H.P. each. The wagon stock, which was specially designed by the manufacturers to facilitate the loading and unloading of manganese ore with the least possible delay, is of the all-steel box type, each wagon having a carrying capacity of 60 cubic feet (roughly, 3 tons). The whole of the track, plant, locomotive and wagon stock was supplied by Messrs. Orenstein and Arthur Koppel with whom orders have also been recently placed for additional wagons. It may be mentioned that the whole of the outturn from the Ghuriajhor Mines comes to Calcutta for shipment and as illustrative of the far-reaching effects of the opening of even such a short length of line as the Gangpur Light Railway, it has been found necessary to make special arrangements at the Kidderpore Docks to receive, stack and ship the manganese ore, as the presence of the line has so largely increased the outturn of the mines that ore is being sent down in greater quantities than it has ever been sent before and the arrangements for the handling of it which have hitherto prevailed at the Docks have had to be revised and their scope enlargened to admit of the altered circumstances of the traffic being met. The new arrangements reflect the greatest credit on the Port Commissioners who are in charge of the traffic arrangements at the Kidderpore Docks.

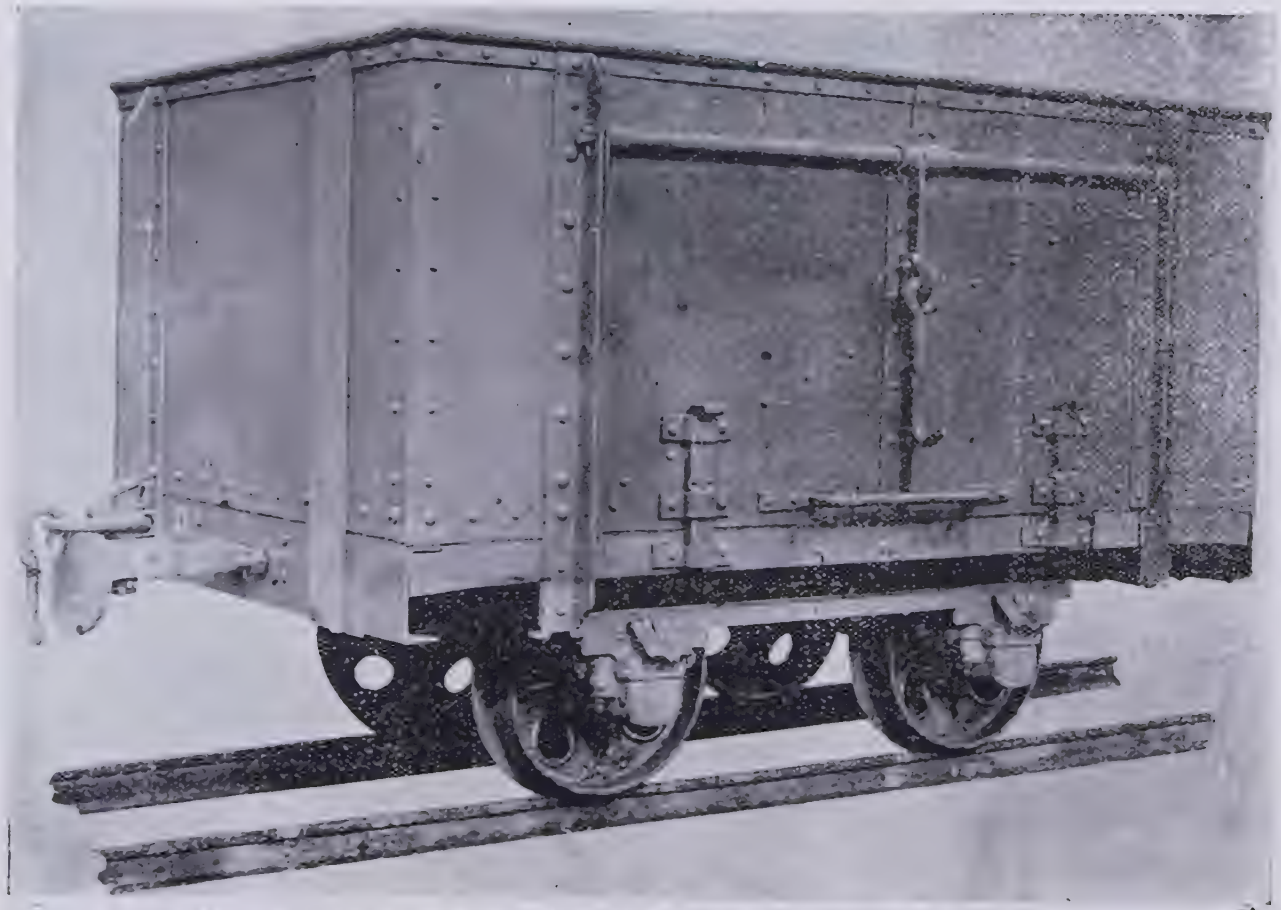
The illustrations given are calculated to give the reader a good idea of the line, its formation and the rolling-stock in use.

(2) THE TUMSAR ROAD-KATANGI LIGHT RAILWAY.

This is another light line on the 2 feet gauge built to serve deposits of manganese ore in the Central Provinces. It takes off from the Bengal-Nagpur Railway at the station of Tumsar Road, mile 651 from Howrah, and runs to Katangi, a length, with sidings,

A BRIDGE, GANGPUR LIGHT RAILWAY.

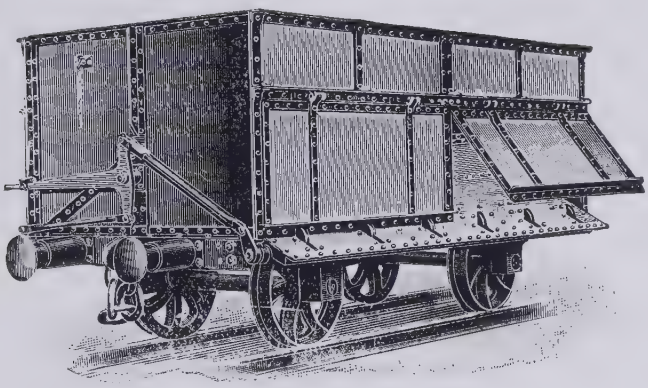
LOCOMOTIVE AND TRUCKS, GANGPUR LIGHT RAILWAY.



of 42.89 miles. It may be remarked in passing, though not *appropos* of the line, that the town of Tumsar, which is about two and a half miles from the station called Tumsar Road, has a large grain trade and possesses an unique building for a mofussil town in India in the shape of a corn exchange. Most travellers who have journied the overland route between Calcutta and Bombay *viâ* the Bengal-Nagpur Railway will recollect passing through Tumsar Road, a way-side station situated in a perfectly flat country, but from which can be seen in the dim distance a range of dark, forbidding looking hills standing out against the sky-line in bold relief. It is in the vicinity of these hills that the manganese deposits are to be found and thither the Tumsar Road-Katangi Light Railway wends its way. As it leaves the main line station it runs for some distance along the side of the public road on either side of which a row of sirius trees form a cool avenue, and, again, it passes just below Tumsar Road, under the Bengal-Nagpur Railway line which crosses it over a bridge. The permanent way of the Tumsar Road-Katangi Light Railway consists of 18lb. steel rails laid on wooden sleepers spaced two feet apart and is partially ballasted. The locomotive stock used for working the traffic consists of 30 H.P. four-wheel coupled and 50 H.P. six-wheel coupled engines, these as also a portion of the wagon stock in which the ore is transported from the Mines having been supplied by Messrs. Orenstein and Arthur Koppel. An illustration of one of the wagons is given and is of interest as it depicts almost the very latest development in comparative high capacity to low tare in this class of stock. It will be readily understood by all railwaymen that, in actual fact, capacity and tare, owing to prevalent limitations, count for even more in the construction of light railway stock than they do in the construction of wagons intended for service on a standard or metre gauge line, and modern-day mechanical genius has long been at work endeavouring to construct a narrow gauge truck which will give the maximum possible carrying capacity combined with the lowest tare consistent with resistance and a general factor of safety. The wagon illustrated is a good example of later efforts in this direction, so far as a truck designed especially for the transporting of a heavy substance like ore is concerned, and the use of the type in connection with the carrying of manganese ore from the mines in the vicinity of Katangi is stated to have been accompanied by distinct success.

(3) THE BALASORE-NILGIRI LIGHT RAILWAY.

If it is permissible to make what might almost be termed a political observation, it might be said that the Balasore-Nilgiri Light Railway is one of the best examples of efficient and well directed swadeshism that India can boast of. Messrs. K. M. Dey & Co., a wealthy Bengalee firm of Calcutta, being proprietors of extensive granite quarries at Nilgiri in Orissa, found that the great demand that had arisen for the stone necessitated a large increase in their staff of miners to enable them to meet it, but with the primitive means then at their disposal it was impossible to transport this increased output to the nearest point of the railway sufficiently quickly. The firm therefore decided to construct a short 2 feet 6 inch gauge railway from the Mines to Balasore Station on the Bengal-Nagpur Railway (East Coast Section), a distance of some 13 miles through a country that is largely flat. Sanction having been obtained in due course, construction work was started in August 1908 and the line opened in January 1909. For the present, the only commodity transported is granite, but it is probable that sanction will be sought in time to the carriage of passengers and general goods traffic, while the line itself may yet be extended over the hills, to which it now runs, into the heart of Orissa, a project involving this being under consideration. It is a concern with a future before it and an energetic management should make it the financial success it certainly deserves to be. The two illustrations given depict the locomotives and rolling stock of the line, which have been supplied by Messrs. Orenstein and Arthur Koppel. The line possesses a saloon carriage built in the Howrah Workshops of Messrs. Burn & Co., which is of interest as it shows what excellent workmanship in this line the firm referred to are capable of turning out of their workshops. This saloon has a length over headstocks of 15 feet 9 inches, a width over solebars of 6 feet 4 inches and a height of 6 feet from floor to cant rail. It is divided into two compartments, the saloon proper and a servants' room. The former is upholstered in dark green "pantasote," the floor being covered with green linoleum to match. In one corner a completely fitted lavatory with collapsible fittings has been installed, while illumination is supplied by single and double candle lamps of the East Indian Railway pattern The body of the coach is of Burma teakwood, the inside and outside panels being of mild steel with teak moulding, stained and polished to resemble mahogany. The roof and upper outside panels are painted

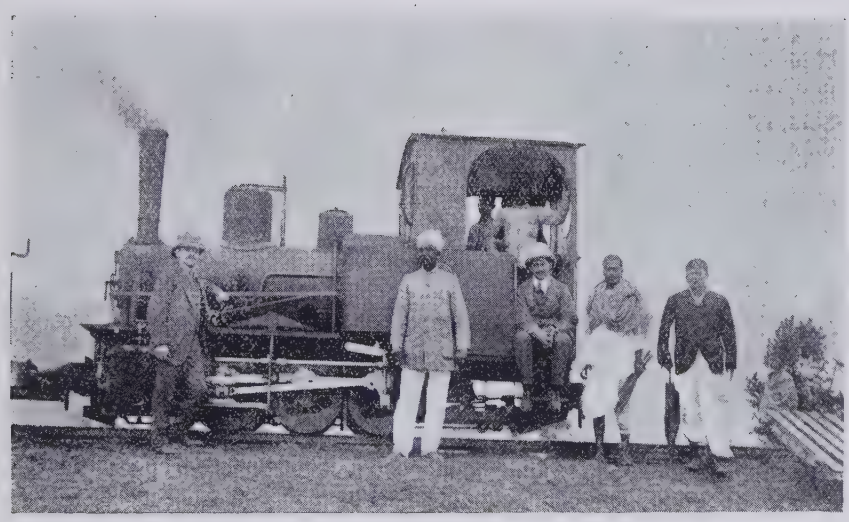


HIGH CAPACITY SELF-DISCHARGING ORE WAGON, 2′-6″ GAUGE.

VIEW ON THE BALASORE-NILGIRI LIGHT RAILWAY.

white with dark brown lining, while the waist panels are painted teak colour, grained and varnished, the whole forming a neat and effective finish. Glass windows, louvres and gauze frames are provided. The body is carried on a channel steel underframe upon Messrs. Burn & Co.'s standard wheels, axles and axleboxes. Taken all round, the saloon besides having a smart appearance and being excellently constructed, provides for ease and comfort in travelling which it would be difficult to excel in a special gauge carriage.

It may be mentioned in passing that the blasting work at the Nilgiri Mines is largely done by means of Nobel's Explosives which have been largely used in connection with the construction of Light Railways in India.



LOCOMOTIVE, BALASORE-NILGIRI LIGHT RAILWAY.

TEMPORARY MILITARY LIGHT RAILWAYS.

THE DELHI DURBAR LIGHT RAILWAY.

TEMPORARY MILITARY LIGHT RAILWAYS.

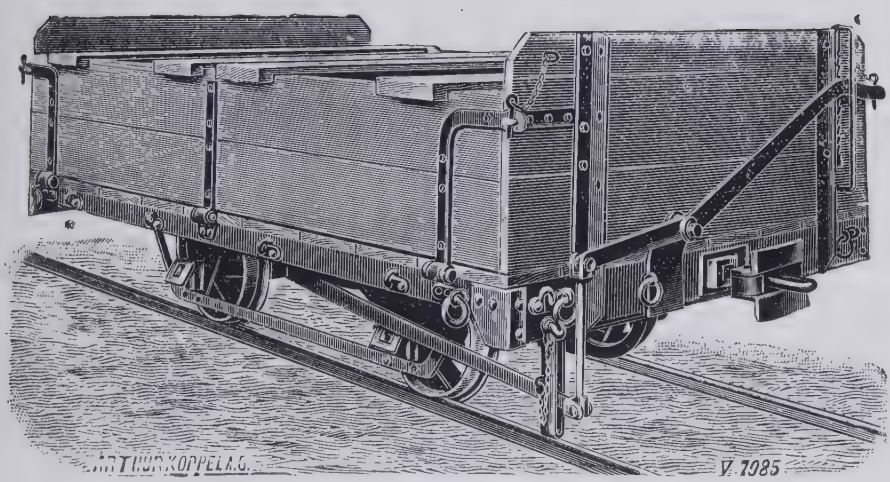
THE DELHI DURBAR LIGHT RAILWAY.

MODERN conditions of warfare and military display in the piping times of peace have rendered speedy and facile means of transportation an absolute necessity and it has naturally followed that the utility of the temporary or portable light railway has been recognised by military authorities all over the world. The laying of these portable lines now forms part of the training of the Engineers and Sappers in both the British and Indian services. Although not as a rule laid as permanent lines, being merely temporary structures for the passing convenience of military mobilization or a similar purpose, they are of interest as they show a specialized side of the varied uses to which the light railway can be put, particularly at short notice in times of emergency, and the rolling-stock utilized is apt to be singular of its kind, differing greatly from that found on the usual light line.

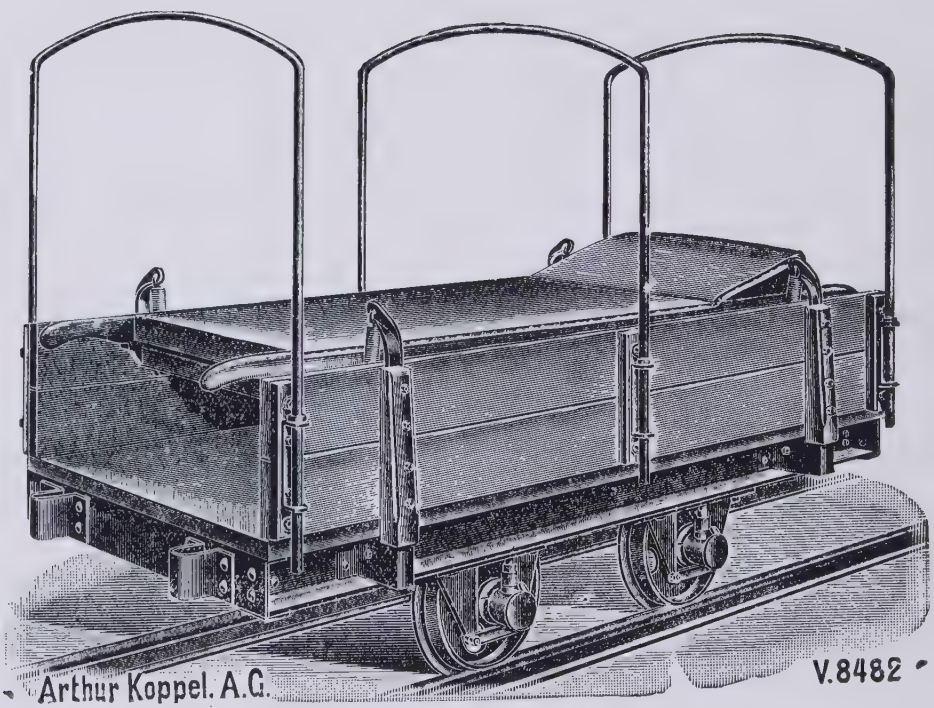
A light railway the fame of which will go down to history, one typical of portable lines, was that laid in connection with the Delhi Durbar in view of the necessity of relieving the traffic on the roads leading from Delhi to the various Durbar camps as it was considered, rightly so as subsequent events proved, that during the Durbar period the vehicular traffic on these roads would be enormous, due not only to the rush of people from the city, but also to the numbers of visitors who would require to get about from place to place and the continual passage of troops from camp to camp. The line laid had a total length of seven miles on the 2 feet 6 inch gauge, the greater part of which was practically a surface line, but on the Ridge section (the historically famous Delhi Ridge) conditions were less favourable, the ground being broken and rocky, whilst the Ridge itself over which the metals had to be laid, presented an irregular mass of practically bare rock rising abruptly, at the lowest point, to a height of over 21 feet above the normal ground level. The main line ran from the Kashmir Gate to the Polo Grounds, being laid as a double line with a loop at each end. The effect produced was, therefore, that of a continuous circular railway divided into thirteen sections, round which trains followed each other without the

necessity of shunting. In fixing the number of stations it was considered that as the maximum number of trains likely to be run at one time was ten, a circular line with about thirteen sections would probably be the most suitable having regard to economy and convenience of working. The three space sections provided against a general block or congestion occurring and a greater number of stations would have made travelling between the termini too slow, as also it would have meant increased cost in constructing and equipping the additional stations and in maintaining extra staff to work them. For block working purposes the stations were sufficiently close together to admit of trains being run at intervals of eight minutes.

To economize material the tracks of the double line were spaced throughout at 8 feet centres only and 5 feet was fixed as the minimum distance of the nearest fixed structure, a distinct infringement, it may be noted, of the Government provisional standard dimensions for 2 feet 6 inch gauge tracks. For two tracks the width of formation was 16 feet in bank and 20 feet in cutting, allowing for 2 feet side drains. On the single line 8 feet and 12 feet were the respective measurements adopted. The maximum gradient was 1 in 80 and the sharpest curve 120 feet radius. The first portion of the earthwork was carried out by contract, as was also the cutting of the majority of the culverts and the spreading of the permanent-way material ready for laying. Thereafter construction work was taken in hand by two companies of Sappers and Miners who commenced the platelaying immediately on their arrival. Dry stone retaining walls were used on the Ridge to reduce the quantity of material required for the embankment at this point, a plentiful supply of stone being available on the ridge summit. This cutting, it is stated, comprising about 16,000 c. ft. of rock, some of which was very hard, was taken out by a party of Bombay Sappers in 24 days, dynamite being the explosive used. Of the bridges, that over the Najagarh Canal was a timber pile structure of three spans of 10 feet centre to centre of piers. The girders which were continuous over the three spans, were 12 inch by 12 inch fir baulks and the rails were laid directly on them. Each pier was braced transversely by 9 by 4 inch Sâlwood planks bolted to the piles and to the ends of the transom by 1 inch bolts, and the two centre piers were also braced together longitudinally to check vibration. Stone-in-mud masonry retaining walls, pointed with lime mortar, were built round



TRUCK USED ON THE DELHI DURBAR LIGHT RAILWAY.



MILITARY AMBULANCE TRUCK FOR USE ON LIGHT RAILWAYS.

the abutment piers to support the earthwork in the approaches. There were no other bridges of any importance. With the exception of a 6 foot arched culvert on the Ridge section and a 3 foot arch near the Mori Gate station, the remaining openings were all 1 foot 6 inch or 2 feet flat-topped culverts, unserviceable sleepers being used for covering them owing to the difficulty experienced in procuring local stone in sufficiently large slabs for the purpose.

Work on the line was commenced on the 1st August 1902. The main line was inspected and passed to carry passenger traffic at 12 miles an hour on the 29th of the following November and it was opened to public traffic on the 1st December. When completed, it consisted of (1) main line 4·00 miles of double line, (2) Amphitheatre Branch 1·78 miles of single line, and (3) Review Branch 1·45 miles of single line. Having served its purpose, it was closed on the 18th January 1903 having during the period it was open earned a gross amount of Rs. 68,222-11-0 against a total cost of Rs. 1,25,856-1-9 for constructing and working.

The total number of locomotives utilized was twelve, of which six were lent by the Khushalgarh-Kohat-Thal Railway, all of the same type, four-coupled tanks with pairs of leading and trailing wheels 1 foot 7 inches in diameter and rigid wheelbase of 4 feet. The weight in working order was 11·6 tons of which 6·5 tons was on the coupled wheels. The remaining six engines were new ones obtained from England. The carriages used were 120 in number, all of the "military service" type and supplied by the Military Department which had previously obtained them or at least a portion of them from Messrs. Arthur Koppel & Co., a firm which has also supplied trucks of other types for use on military light lines. The first of the accompanying illustrations shows the type of truck used on the Delhi Durbar Light Railway and the second a special type of military truck, built to the design of the firm named, which is fitted with a stretcher suspended on springs, steel hoops being attached to the sides for securing the awning. The truck is fitted to flat steel corner buffers with outside spring roller bearings, and of its kind is about as perfect a carriage as could be devised.

The most comprehensive work obtainable on the Delhi Durbar Light Railway is that entitled "Delhi Coronation Durbar Light Railway" written by Captain H. A. L. Hepper, R.E., and Lieutenant C. L. Magniac, R.E., and issued by the Government of India as a

Technical Paper. The writer is indebted to this for a large portion of the information given in the preceding pages and he takes this opportunity of making the acknowledgment.

Military light railways do not, perhaps, possess very much interest for the average railwayman, but the portable lines Sappers and Miners lay do not differ in any way from others laid for purposes other than military, say for instance, for temporary forest, tea garden or mine work, and the circumstances attendant on the construction of the Delhi Durbar Light Railway, together with the specific purpose for which it was built, were certainly singular and are such as to make it memorable to most railwaymen, and the tale of it will doubtless continue to be told for many a long year to come.

GENERAL TRAFFIC LIGHT RAILWAYS.

THE BENGAL PROVINCIAL RAILWAY.
THE GWALIOR LIGHT RAILWAY.
THE JORHAT STATE RAILWAY.
THE COOCH-BEHAR STATE RAILWAY.
THE POWAYAN STEAM TRAMWAY.
THE GAEKWAR'S DABHOI STATE RAILWAY.

FIRST AND SECOND CLASS COMPOSITE CARRIAGE, BENGAL PROVINCIAL RAILWAY.

GENERAL TRAFFIC LIGHT RAILWAYS.

(1) THE BENGAL PROVINCIAL RAILWAY.

KNOWN also as the Tarkeswar-Magra Railway, this line runs from Tarkeswar to Magra in Bengal, a distance of about 33 miles on the 2feet. 6inch gauge, with a branch from Magra to Tribeni a length of 2·15 miles. The construction of the main line was sanctioned in 1891 and of the extension in 1903, these being opened to traffic in 1895 and 1904 respectively. It is interesting to note that such was the faith the Company (which is almost entirely composed of Indian shareholders) had in the venture, that it purchased itself, out of its original capital, the land necessary for the construction of the main line, that for the extension only having been given by Government. The permanent-way consists of 30-lb. flat-footed steel rails laid for a distance of 10 miles on transverse steel sleepers and for the remainder of the length on Burmese pyngado wood sleepers, while the sleepers on the Tribeni extension are exclusively of Sâlwood. It is ballasted with sand and broken brick throughout. The sharpest curve is one of 716·25 feet radius, the ruling gradient of the main line being only 1 in 1,000, though short gradients of 1 in 500 and 1 in 700 occur at bridge approaches and from the bridge under the East Indian Railway at Magragunj station the line is on a gradient of 1 in 350. On the Tribeni extension the ruling gradient is 1 in 500.

The Bengal Provincial Railway is the property of a Company which maintains and works it under two agreements, one executed in 1890 between the Company and the District Board of Hooghly and one executed in 1904 between the Company and the Secretary of State for India. The District Board may acquire the line and its equipment, if it so wishes, under the provisions of the Bengal Tramways Act of 1883, at the end of 21 years after the first opening to traffic by paying the promoters a sum equal to two-fifths in excess of the original capital outlay.

As a line built to carry no one particular commodity, but for the purpose of general traffic, it naturally carries the varied

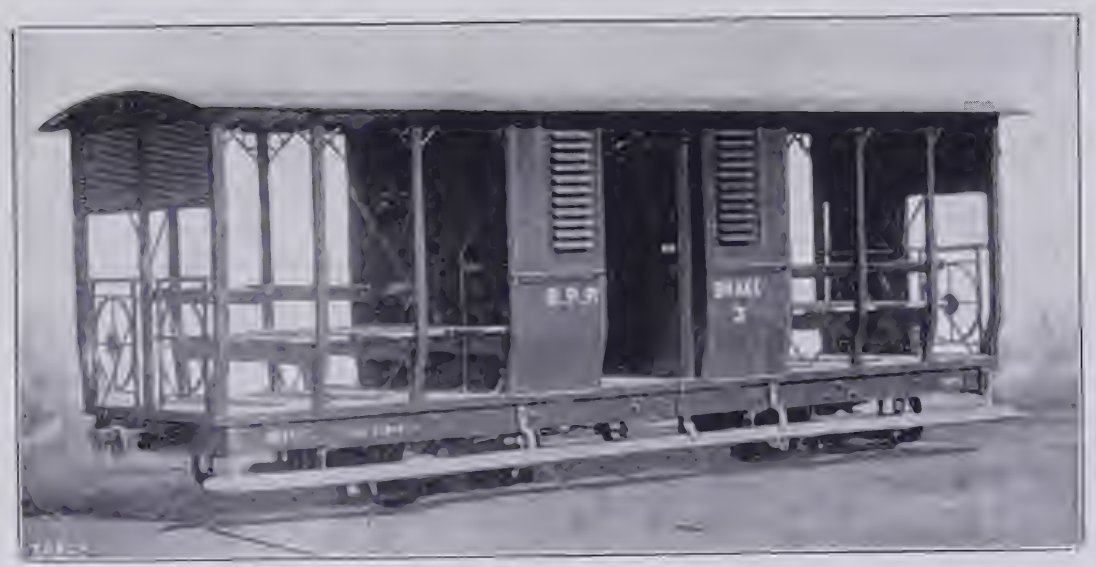
assortment of consignments that is usual to light lines, the following table being illustrative of the bulk of its goods traffic in the year 1907 :—

Commodity.	Quantity (tons)	Earnings. (Rs.)
Oil-cake ...	1,733 ...	2,427
Rice in the husk ...	1,065 ...	1,270
Rice not in the husk ...	151 ...	212
Wheat flour ...	236 ...	282
Raw jute ...	493 ...	664
Mineral substances ...	24,973 ...	10,773
Mustard and Rape oil ...	183 ...	254
Mustard and Rape seeds	154 ...	187
Provisions ...	1,606 ...	1,706
Salt ...	141 ...	205
Sugar ...	223 ...	243

The comparatively low amount of freight earned on the tonnage of each of the commodities shown is, of course, due to the short lead (or distance carried) a thing that all light railways have more or less to contend with. A railway which has a length of several hundreds of miles and which carries its goods traffic an average distance of perhaps a hundred miles or more is naturally more advantageously placed than a line of 30 miles in length even supposing that every consignment offered was to be transported the entire distance. As a direct result of this, economy in handling and rapidity in transit means even more to a short light railway than it does to an extensive broad gauge system, though with both lines these points are material factors in economic transportation.

With regard to passenger traffic also, the line is not very happily situated as it has to compete with neighbouring lines and, again, such passengers as it does carry can only give a short lead and consequently, reduced earnings under this head in a corresponding degree. The number of passengers carried is, however, steadily increasing year by year and steps are being taken by the management to attract and hold this class of traffic.

Financially, the Bengal Provincial Railway if it cannot be said to have been a highly remunerative venture, has at least earned an uniformly fair rate of *net* interest on its total capital outlay, and while three per cent. cannot be characterized as anything excessive in the way of interest, the fact that it is being earned is quite sufficient to



COMBINED THIRD CLASS CARRIAGE AND BRAKE-VAN, BENGAL PROVINCIAL RAILWAY.

COVERED GOODS WAGON, BENGAL PROVINCIAL RAILWAY.

entirely justify the construction and continued existence of the concern. The subjoined table gives the working statistics for the five years which ended in December 1907 :—

Year.	Total capital outlay.	Gross earnings.	Net earnings.	Percentage of net earnings on total capital outlay.	Earnings per mile per week.	Proportion of expenses to earnings.
	Rs	Rs.	Rs.	Rs.	Rs.	
1903	10,15,987	85,546	25,350	2·50	53	70·37
1904	10,44,975	89,735	27,564	2·63	52	69·28
1905	10,46,664	86,838	21,679	2·07	50	74·81
1906	10,73,037	1,00,072	32,762	3·05	58	67·26
1907	10,92,156	1,10,238	34,500	3·16	64	68·70

One specially noticeable point is given prominence to by a careful study of these figures, and that is, given the possibility of constructing a light line at a comparatively low capital cost in spite of subsequent adverse working circumstances the possibility of earning a dividend on the investment is practically assured. The 35 existent miles of the Bengal Provincial Railway have been constructed and equipped for traffic at a cost, down to the end of 1907, of Rs. 10,92,156, which gives Rs. 31,204·45 per mile of open line being worked. The high percentage of working expenses to earnings denotes that traffic is carried on under circumstances which may be considered to be, in India at any rate, not of the most favourable. In spite of this, however, the capital expenditure on construction and equipment (other than may have been paid for out of Revenue) has been sufficiently low to admit of net interest being earned on the investment.

The engine stock employed at the time of writing consists of five locomotives, the first three having been built in England by Messrs. Manning Wardle & Co. and the last two by the Vulcan Foundry, Limited, of Newton-le-Willows. A further six engines have been ordered and will shortly be available for traffic, bringing the total number up to eleven. Both those in service and those being obtained are of the 2-4-0 tank class, a type that finds considerable favour on light railways in India. The coaching and wagon stock consists of

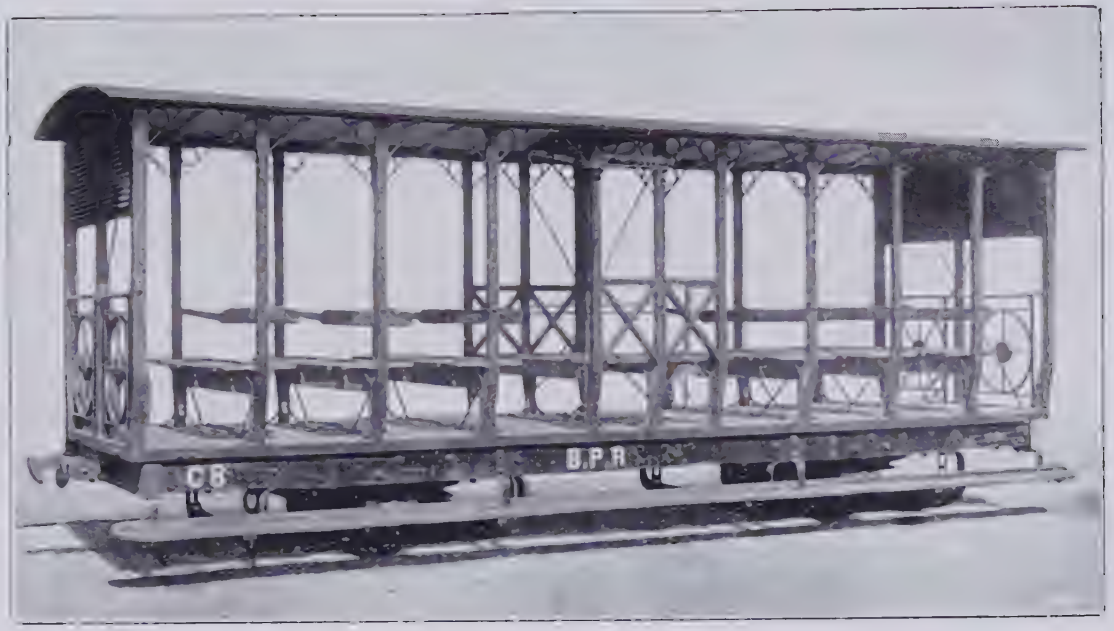
25 Passenger Coaches.
20 Covered Wagons.
15 Low-sided Wooden Trucks.
12 Low-sided Iron Trucks.

The coaching stock has all been built and supplied locally by Messrs. Burn & Co., the great Howrah engineering firm, and the accompanying illustrations of it are representative. The first shows a 1st and 2nd class composite four-wheeled coach with a length over headstocks of 21 feet and a width over mouldings of 6 feet. The first class compartment is upholstered in leather with spring cushioned seats. The second class compartment is fitted with lath benches, and sliding venetians and glass shutters are provided on the sides of the coach. The second illustration depicts a combined third class carriage and brake-van, the length of which over headstocks is 21 feet, wheelbase 11 feet, height from rail level to top of roof 9 feet, and the width over mouldings 6 feet 6 inches, the roof having a projection of 6 inches on either side. The third reproduction is illustrative of a covered goods wagon in use, a type that has been specially designed for light railway working. The wagon has an internal length of 18 feet and total wheelbase of 11 feet. It is interesting to note that the bodies of all the wagons of this type, as originally supplied, were carried on six plate springs, but these having been found inadequate for the load on them, have since been replaced with nine plate springs, the alteration having effected the purpose for which it was made, that of enabling the wagons to be loaded with safety to their full carrying capacity. The fourth illustration is of an open-sided third class carriage, designed to carry thirty-two passengers, of which the line has twelve in use.

The Bengal Provincial Railway is managed as Manager and Chief Engineer by Mr. K. N. Sen Gupta, to whose courtesy the writer is indebted for much of the information given concerning it.

(2) THE GWALIOR LIGHT RAILWAY.

A RAILWAY built on the narrowest gauge, the 2 foot, this line is the property of the Gwalior Durbar and is worked under an agreement dated the 11th October 1900 between the Government of His Highness the Maharajah Scindia of Gwalior and the Indian Midland Section of the Great Indian Peninsular Railway. It is divided into three main sections, the Gwalior-Bhind 52¼ miles long, the Gwalior-Sipri 74 miles long and the Gwalior-Sabalgarh 57¼ miles long, all single line throughout the total length of the three sections constituting it the longest narrow gauge railway in India. In addition to this, also, some 66½ miles were under construction in 1908, portions of which have doubtless since been opened to traffic. The permanent-way consists of 30lb. flat-footed steel rails laid on sâlwood



OPEN SIDED THIRD CLASS PASSENGER CARRIAGE. BENGAL PROVINCIAL RAILWAY.

and steel trough sleepers, the track being fully ballasted throughout with stone, sand and *moorum*. The ruling gradient is 1 in 60 while the sharpest curve out of station yards has a radius of 955 feet. Within station yards, the sharpest existent curve has a radius of 200 feet.

Under the agreement already referred to, the gross traffic receipts are collected and treated as receipts of the Indian Midland Railway and from them are deducted the actual expenditure incurred in traffic and audit, for station and train staff, audit clerks, printing and stationery and all other expenses connected therewith. Five per cent. per annum is then deducted for construction and maintenance of accommodation required for the exclusive use of the light railway, 7½ per cent. for ballast, permanent-way, etc., including maintenance and renewal, plus 10 per cent. to cover supervision and general charges other than those rendered in accounts. The balance of the earnings is then paid over to the Gwalior Durbar and for the last two or three years it has been sufficient to give a net return of something under 2 per cent. on the total capital outlay, not a large interest from a financier's point of view perhaps, but sufficient to show that the line, which was primarily intended to open up and develop the Gwalior State, is serving its purpose and serving it at no large amount of expense to its owners as the net returns are probably sufficient to pay a half if not two-thirds of the fixed interest on the capital, a thing that cannot, most unfortunately, be said of all State light railways.

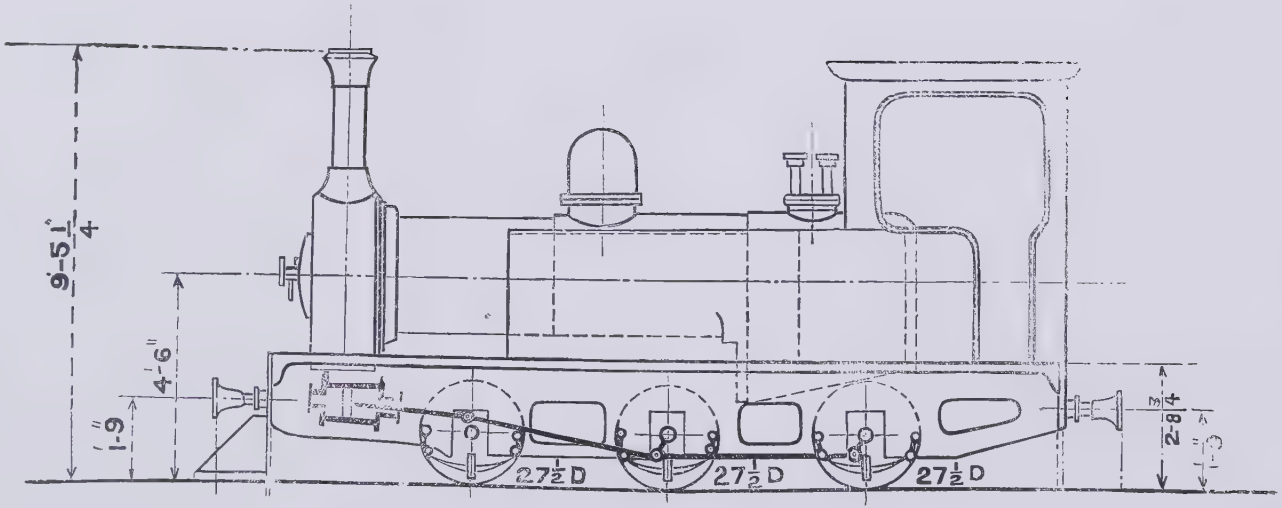
The following figures, given in tabular form, contain the working statistics from the year 1903 to 1907 and they serve to show that the total receipts are steadily ascending, holding out the hope of a better return on the capital outlay within the next few years :—

Year.	Total Capital Outlay.	Gross Earnings.	Net Earnings.	Percentage of Net Earnings on total Capital Outlay.	Earnings per mile per week.	Proportion of Expenses to Earnings.
	Rs.	Rs.	Rs.		Rs.	
1903	41,76,953	1,66,002	68,226	1·63	25	58·90
1904	46,62,993	1,83,284	52,501	1·13	22	71·36
1905	54,72,847	1,89,735	52,745	0·96	20	72·20
1906	57,87,428	2,58,222	1,12,211	1·94	27	56·54
1907	63,00,513	3,08,791	1,15,709	1·84	32	62·52

(3) THE JORHAT STATE RAILWAY.

If anyone takes up a map of India upon which the many railway systems that run throughout the length and breadth of the country are shown, and should happen to glance at the extreme north-eastern corner of it where the province of Assam is located, he would find a little red streak, scarcely discernable, which represents the Jorhat State Railway, perhaps the only short length of line in India which has been constructed by the Government for the specific purpose of materially assisting a great industry. The line was constructed out of provincial revenues by the erstwhile Administration of Assam to serve the numerous tea gardens which abound in the vicinity of Jorhat. It should therefore, perhaps, have been treated under the head "Plantation Railways," as its main goods traffic consists of tea, machinery for the tea factories, rice for the consumption of the tea garden coolies, in short, anything connected with the great tea industry upon which Assam lives and thrives, and which gives employment to many thousands of Europeans and Indians at all seasons of the year.

The Jorhat State Railway is divided into two portions both of which connect with the Assam-Bengal Railway, the main line at Titabar Junction whence it runs to Borghop, a distance of 24·75 miles, and a branch of 7 miles which is known as the Mariani Branch and which connects with the trunk line at a station of the same name. It is, therefore, 31·75 miles long in all, on the 2 feet gauge. Excepting 2·51 miles of line between Jorhat and Gosaigaon which is laid with 30lb. flat-footed steel rails, and about a mile. between Jorhat and Chenimari which is laid with 25lb. steel rails, the line is laid throughout, including the section from Gosaigaon to Borghop, with 18lb. steel rails, the permanent-way being unballasted. The sharpest curve is one of 480 feet radius, and four miles are on a gradient of 1 in 800. As already stated, the line is the property of the State and it is worked by the State also. The construction was taken in hand in 1883, the main line being opened to traffic in 1887 and the branch in 1895, and it may, therefore, be regarded as a well established and almost an old system, in comparison at any rate with the age of the majority of light lines in this country. Despite this, however, it has never proved a financial success and its receipts vary considerably from year to year. This is, of course, because it is almost entirely dependent upon climatic and attendant conditions. When these are such as to result in a



A LOCOMOTIVE, COOCH BEHAR STATE RAILWAY.

Height from rail level to centre of smokebox door	4′ 6″
Length of frame	17′ 2″
Length over buffers	19′ 7¾″
Wheelbase	8′ 6″
Total weight in full working order	13 tons 4 cwt. 3 qrs.
Weight on axles—	
Leading	4 „ 2 „ 1 „
Middle	4 „ 11 „ 0 „
Rear	4 „ 11 „ 2 „

Tank capacity	100 gals. water.
Coal „	20 c. ft.
Cylinders, diameter & stroke	8½″ × 12″
Working boiler pressure	150lbs. per sq. inch.
Number of tubes	73, 1⅜″ diameter outside.

Heating surface—	
Tubes	210 sq. ft.
Firebox	29 „
Total	239 „
Tractive Force at 90% of boiler pressure	4,256lbs.

good tea season, in a heavy crop, which means increased quantities of tea offerings and also of rice to feed the larger number of hands employed in the gardens under such circumstances, the earnings of the line go up. When conditions are adverse, when there is a small crop and a lesser number of hands employed in cultivating it and producing the tea, the earnings go down. In brief, the earnings of the system, to a very large extent, reflect the Assam tea trade. Situated also as the line is in the very heart of almost the most inaccessible province in India, its working expenses are naturally high in comparison with the earnings, in fact they have not fallen below 85 per cent. during the last ten years, while as recently as 1904 they were up to 105·17 per cent. Once, in 1898, the net earnings were sufficient to give a return of 2·21 on the total capital outlay, which at that time was Rs. 9,09,445, but despite this the loss to the State in that year was Rs. 16,004, as the net earnings were insufficient to meet tne fixed interest charges by that amount.

The line carried 13,552 tons of general merchandise (largely tea) during the year 1907 upon which it earned a revenue of Rs. 57,398, and its gross earnings in that year were Rs. 91,667 in all, or Rs. 55 per open mile of line per week.

(4) THE COOCH BEHAR STATE RAILWAY.

This interesting and financially successful line, situated in the Native State of Cooch Behar in Eastern Bengal, is worked by the Eastern Bengal State Railway on behalf of the promoters and proprietors, the Cooch Behar Durbar. Under the agreement between the two parties, now in force, which may be terminated by six months notice given by either side, the Eastern Bengal State Railway receives 40 per cent. of the gross earnings for maintenance and working provided that when its stock is used for the conveyance of any traffic on the Cooch Behar Railway it receives and retains a sum up to but not exceeding 45 per cent. of the gross earnings obtained from the use of such stock. The percentage of working charges covers the cost of what are technically known as "new minor works" up to the limit of Rs. 30 per mile per annum. The Eastern Bengal State Railway has full control over and fixes all rates and fares.

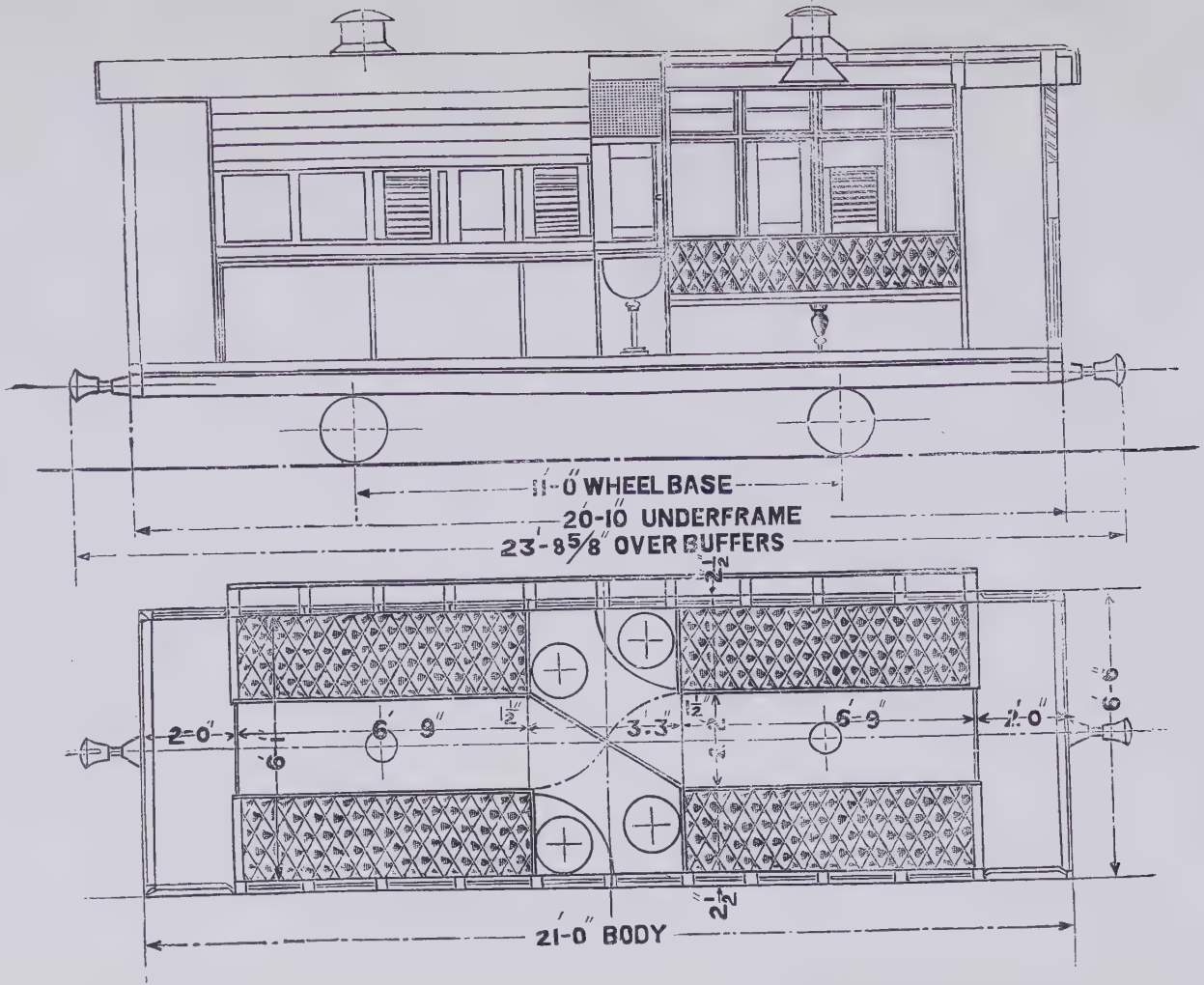
The Cooch Behar State Railway is 33·60 miles long on the 2 feet 6 inch gauge, though it may be mentioned in passing that so successful

has the working of the line on the narrow gauge proved, that the gauge is to be altered to the metre (3 feet 3⅜ inch), the alteration being designed with the special object of admitting through traffic and interchange of stock with the metre gauge Northern Section of the Eastern Bengal State Railway. The length of 33·60 miles is divided into two sections, the main line 22·15 miles long, and what is known as the Native Section of the Cooch Behar Santrabari Extension, a length of 11·45 miles. The construction of the line was sanctioned in 1891 and it was opened throughout in the year 1900. The permanent-way is laid for 19·55 miles with 25lb. and for 1·83 miles with 41¼lb. steel rails on Sâlwood and Pyngado wood sleepers and for 12·22 miles with 40lb. iron rails on Sâlwood sleepers, both the steel and iron rails being flat-footed. It is unballasted and the sharpest curve is one of 2,000 feet radius, the ruling gradient being 1 in 100.

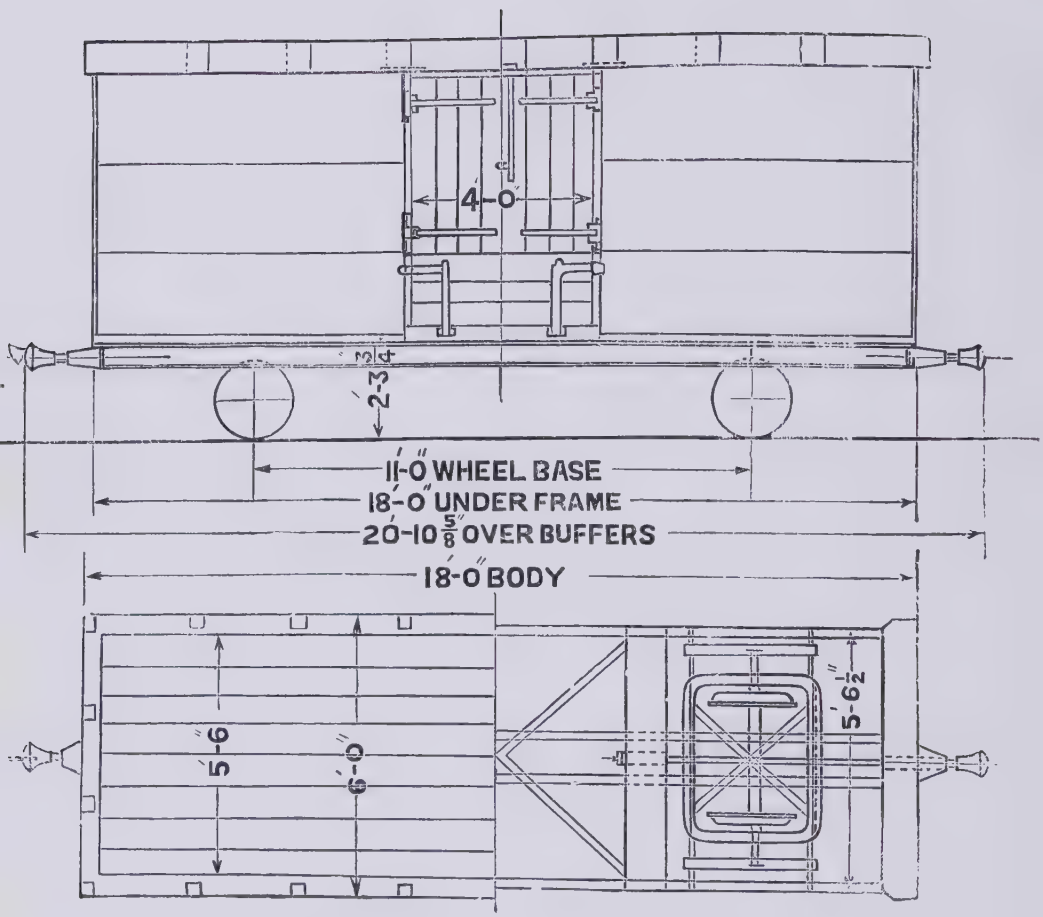
It has already been said that financially the line has proved a success and the following table illustrative of the working statistics from the year 1901 down to and including 1907 shows this :—

Year.	Total Capital Outlay.	Gross Earnings.	Net Earnings.	Percentage of Net Earnings on total Capital Outlay.	Earnings per mile per week.	Proportion of Expenses to Earnings.
	Rs.	Rs.	Rs.		Rs.	
1901	13,94,923	1,27,596	74,667	5·35	72	41·48
1902	13,95,766	1,24,741	74,452	5·33	71	40 31
1903	14,91,329	1,42,540	83,834	5·62	82	41·19
1904	14,71,331	1,47,575	86,996	5·91	84	41·05
1905	14,82,893	1,48,488	87,313	5·88	85	41·20
1906	14,87,786	1,68,754	77.815	5·23	97	53·89
1907	15,20,857	1,79,263	91,484	6·01	103	48·97

These figures are interesting and are certainly worthy of study as they reveal a side of light railway finance which has not yet been disclosed in these pages. The capital outlay per mile of open line has been, comparatively speaking, high, approximating as it does Rs. 45,398 per mile, taking the length at 33½ miles and yet, in spite of this, the earnings have been uniformly sufficient to return a *net* interest on this outlay of well over 5 per cent. The earnings themselves have been nothing out of the common, never having reached a hundred rupees per mile per week until the year 1907 and



FIRST AND SECOND CLASS COMPOSITE PASSENGER COACH, COOCH BEHAR STATE RAILWAY.



IRON COVERED GOODS WAGON, COOCH BEHAR STATE RAILWAY.

the same earnings on the same amount of capital outlay would probably represent a loss instead of gain in working on many another light railway in India. It is apparent, therefore, that the financial success of the Cooch Behar State Railway is neither caused by low capital outlay nor uncommonly high traffic earnings. Where then does it lie? A glance at the proportion of working expenses to earnings answers the question. Only once within the last twelve years (in 1906) have these been as high as 50 per cent., something under 45 per cent. having been the average. It is these favourable working conditions rather than high traffic earnings which tend to make the line a financial success. Add another 15 per cent. to the working expenses, sufficient to make them say 60 or 65 per cent. of the earnings, and the yearly profit would be turned into a yearly loss, and the line would become a failure. We have, therefore, a heavy capital outlay justified not so much by the results of traffic working, though these, of course, are a distinct factor, as by the favourable and economical conditions under which that traffic is being worked. The situation is one which probably has its parallel on more than one other line in India, which is usually regarded as the country *par excellence* of cheap railway working, but it is of distinct interest as it has not been found in any of the light railways described so far.

When the line is converted from the narrow to the metre gauge it will doubtless give even better results than it has hitherto done, though, as is but natural, the cost of conversion which will be met from capital, will add largely to the total amount of this.

(5) THE POWAYAN STEAM TRAMWAY.

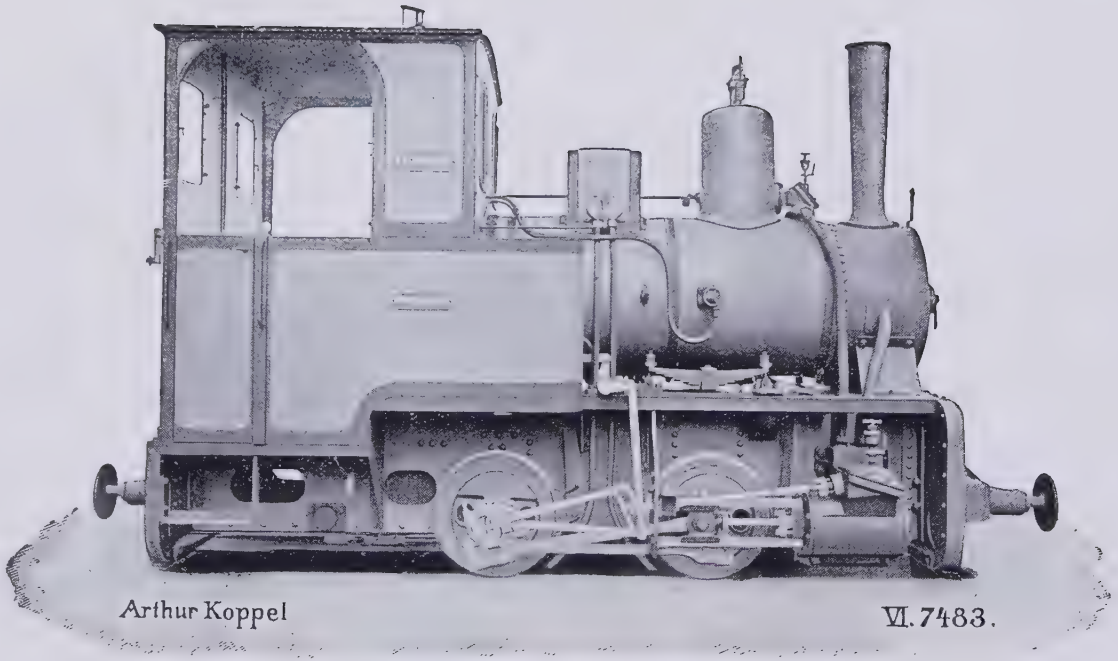
Now an annexé of the Rohilkund and Kumaon Railway, the Powayan Steam Tramway was constructed originally by a Company from which it takes its name, sanction to construction having been accorded in 1889 and the line, which is on the 2 feet 6 inch gauge, opened through in 1894. In December 1900, however, the maintenance and working were taken over by the Rohilkund and Kumaon Railway Company, which, in 1906, by providing a certain amount of capital obtained a proprietary share in the concern.

The line takes off from the Rohilkund and Kumaon Railway at Mailani in the United Provinces of Agra and Oudh and runs thence to Shahjahanpur, a distance of 39·50 miles. Throughout the

permanent-way 25lb. flat-footed steel rails have been laid on sâlwood sleepers in earth ballast. There are no curves with a radius of less than 300 feet and the line is not graded. The system is worked under three contracts, one between the Secretary of State for India and the Powayan Steam Tramway Company and two, dated 1902 and 1906 respectively, between the former and the Rohilkund and and Kumaon Railway Company. The second of these two latter contracts relates purely to the provision of money for capital expenditure and the acquisition by the Railway Company of a proprietary interest in the line. The conditions of working provide for the working agency retaining 70 per cent of the gross earnings until the line is fully equipped, and thereafter the same percentage as that at which the whole system is worked, subject to a minimum of 60 per cent. The percentage so retained may include any single item of capital expenditure not exceeding Rs. 200 subject to a maximum charge of Rs. 20 per mile in each half year. The following are the working statistics for the five years 1903 to 1907 inclusive.

Year.	Total Capital Outlay.	Gross Earnings.	Net Earnings.	Percentage of Net Earnings on total Capital Outlay.	Earnings per mile per week.	Proportion of Expenses to Earnings.
	Rs.	Rs.	Rs.		Rs.	
1903	8,94,619	71,815	28,482	3·18	35	60·34
1904	8,94,751	78,015	30,937	3·46	38	60·34
1905	8,94,751	92,614	36,707	4·10	45	60·37
1906	8,94,751	99,566	39,491	4·41	48	60·34
1907	8,94,751	87,302	34,626	3·87	42	60·34

The latest figure of capital expenditure is significant as it shews that the line, a 2 feet 6 inch gauge one be it remembered, has been constructed and equipped for the low approximate figure of Rs. 22,651·92 per mile, and when we take into consideration the small amount of net interest being returned on the capital outlay by the earnings of the system, it will be readily understood that a most favourable combination of circumstances is requisite if even this small return is to be obtained. Luckily for the existence of the line, these favourable circumstances *are* present—a low capital outlay coupled with a not too high and practically fixed ratio of working



FOUR COUPLED TANK ENGINE, 2'-0" GAUGE.

BUILDERS—ARTHUR KOPPEL & CO.

Diameter of cylinders	..	8¼"	Indirect	..	176 sq. ft.	Weight, empty	.. 7 tons. 5 cwts.
Length of stroke	..	12"	Total	..	198 "	Working order	.. 9 tons.
Diameter of wheels	..	23"	Grate area	..	4¼ "	Tractive force at 60% cylinder pressure	.. 3,630lbs.
Working pressure	..	176lbs.	Wheelbase	..	3' 11"		
Heating surface—			Capacity of tank	..	155 gals.		
Direct	..	22 sq. ft.	Capacity of bunkers	..	101 "		

expenses. A very small increase in either the capital outlay or the percentage of working expenses would be amply sufficient to turn the margin of profit now being earned on the investment, and which as it is is scarcely more than enough to cover fixed interest charges, into a loss The company has been fortunate in having been able to build a line for a sum so small and to get that line worked thereafter at a cost which, considering the small traffic earnings, yet admits of these earnings shewing a profit on the capital expended.

The goods traffic received by the line from the district which it serves for transport to the trunk line, and from the latter to the former, is not of a very varied character and does not assume large proportions. Of the total earnings of the system in 1907, Rs. 87,302, Rs. 33,332 were goods receipts distributed mainly over the following commodities :—

	Quantity Tons.	Earnings Rs.
General Merchandise ...	5,025	... 6,880
Unwrought Timber ...	11,258	... 17,641
Sugarcane produce ...	1,235	... 1,571
Salt	1,002	... 822
Indian Hemp	462	... 1,044
Grain and Pulse ...	3,522	... 4,449

It will be seen from these figures that felled timber constitutes by far the largest commodity transported by the line and it is to be gathered from this that one of the objects of its construction was to develope and serve a well defined forest area in the United Provincess. The object of the promoters is being served and they certainly have no cause at the present day, no matter what qualms they may have felt in the past, to regret their venture.

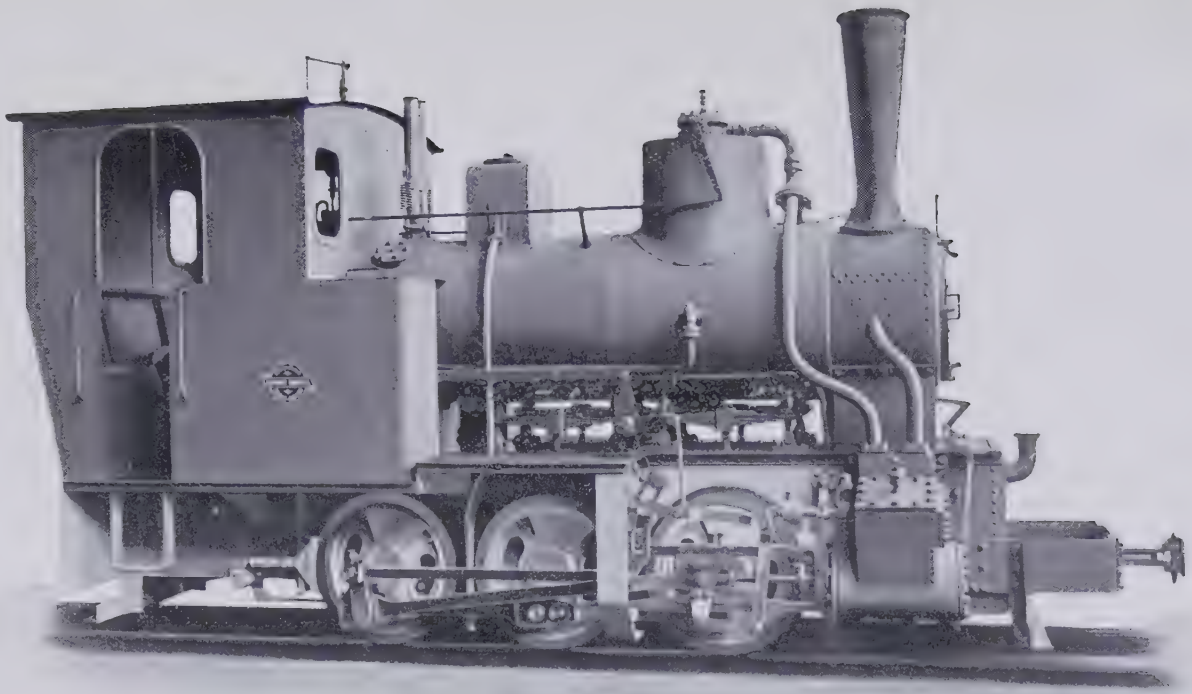
(6) THE GAEKWAR'S DABHOI STATE RAILWAY.

THE property of the Baroda State and one of the longest 2 feet 6-inch gauge lines in the country the Gaekwar's Dabhoi State Railway is also one of the best types of successful light lines. The total length of it is 94·48 miles, divided into three sections—the Miyagam to Chandod 30·62 miles, Dabhoi to Bodeli 22·41 miles, and Dabhoi to Masor Road 41·45 miles. The construction of these three sections was first sanctioned in 1872, 1877 and 1879 respectively, they being opened through out in 1879, 1890 and 1904.

With the exception of about one mile of 28-lb. iron rails, the whole of the permanent-way is laid with 31-lb. flat-footed steel rails on wooden sleepers in sand ballast. The sharpest curve has a radius of 500 feet and the ruling gradient of all three sections is 1 in 400, though short lengths of 1 in 200 and 1 in 300 occur. Although the property of the Baroda State the line is, like most State-owned light railways, worked by a railway company, in this case the Bombay, Baroda and Central India, the existing agreement between His Highness the Gaekwar and the Company providing for the latter working the line at actual cost plus a sum equal to 12½ per cent. of total working expenses for general superintendence, with the provisio that such a sum small not be less than Rs. 500 a month nor more than an average of Rs. 808 in any year. The rates and fares are fixed by the Company with the approval of the State, but it has been arranged that they shall, as far as possible, conform generally to those in force on the Bombay, Baroda and Central India Railway with which the smaller line connects and to which it acts as a valuable feeder. The total capital expenditure down to the end of the year 1907 was Rs. 25,62,795 equal to 27,119·50 per open mile. The gross earnings in the same year were Rs. 4,69,515 and the net Rs. 2,62,120 giving a net percentage on the total capital out of no less than 10·23, a result the best yet achieved, but the working results have been uniformly successful, as for the two years previous to 1907 the net percentage earned was 7·2 and 8·25 respectively. This satisfactory state of affairs is due to a combination of comparatively low capital outlay and a low proportion of working expenses to earnings, the proportion having been for the three years 1905, 1906 and 1907 45·23, 54·75, and 44·17. The effect of both the capital outlay and the proportion of expenses to earnings being substantially increased would be no more than to lower (somewhat appreciably certainly) the net return being earned without making the results of working come out on the wrong side, and without, indeed, even bringing the net percentage below a reasonable sum of fixed interest, say four per cent. It may be noted that so lately as 1903 the line was in the satisfactory position of being able to obtain and pay for three locomotives out of its Revenue account, a thing few lines in India can do or have done.

The Gaekwar's Dabhoi Railway represents the best and most successful form of State enterprise. While considerations incidental to locality are certainly such as to largely account for the satisfactory state of its finances, the fact that it was designed to play an important

part in developing and serving the Baroda State should not be lost sight of. It has played and is playing this part, and is also a substantial source of revenue to the Durbar as well as to the Bombay, Baroda and Central India Railway to which it brings an appreciable amount of traffic. The description of it forms a fitting termination to the description of the light railways of India and the work they are doing as described in the foregoing pages.



A.K. VI 8660.

SIX COUPLED TANK ENGINE, 2′-6″ GAUGE.

Diameter of cylinders	–	9½″	Indirect	..	229 q. ft.	Capacity of bunkers	..	135 gals.
Length of stroke	..	14″	Total	..	253 ,,	Weight, empty	..	9 tons.
Diameter of wheels	–	28″	Grate area	..	4⅞ ,,	Working order	..	12 ,,
Working pressure	–	176lbs.	Wheelbase	..	5′ 7″			
Heating surface—						Tractive force at		
Direct	..	24 sq. ft.	Capacity of tank	..	210 gals. water.	60% cylinder pressure	..	4570lbs.

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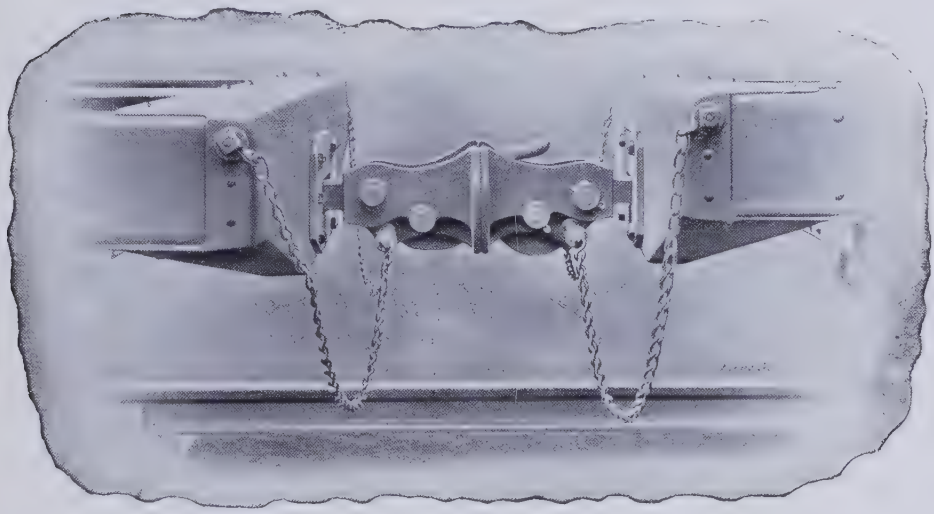

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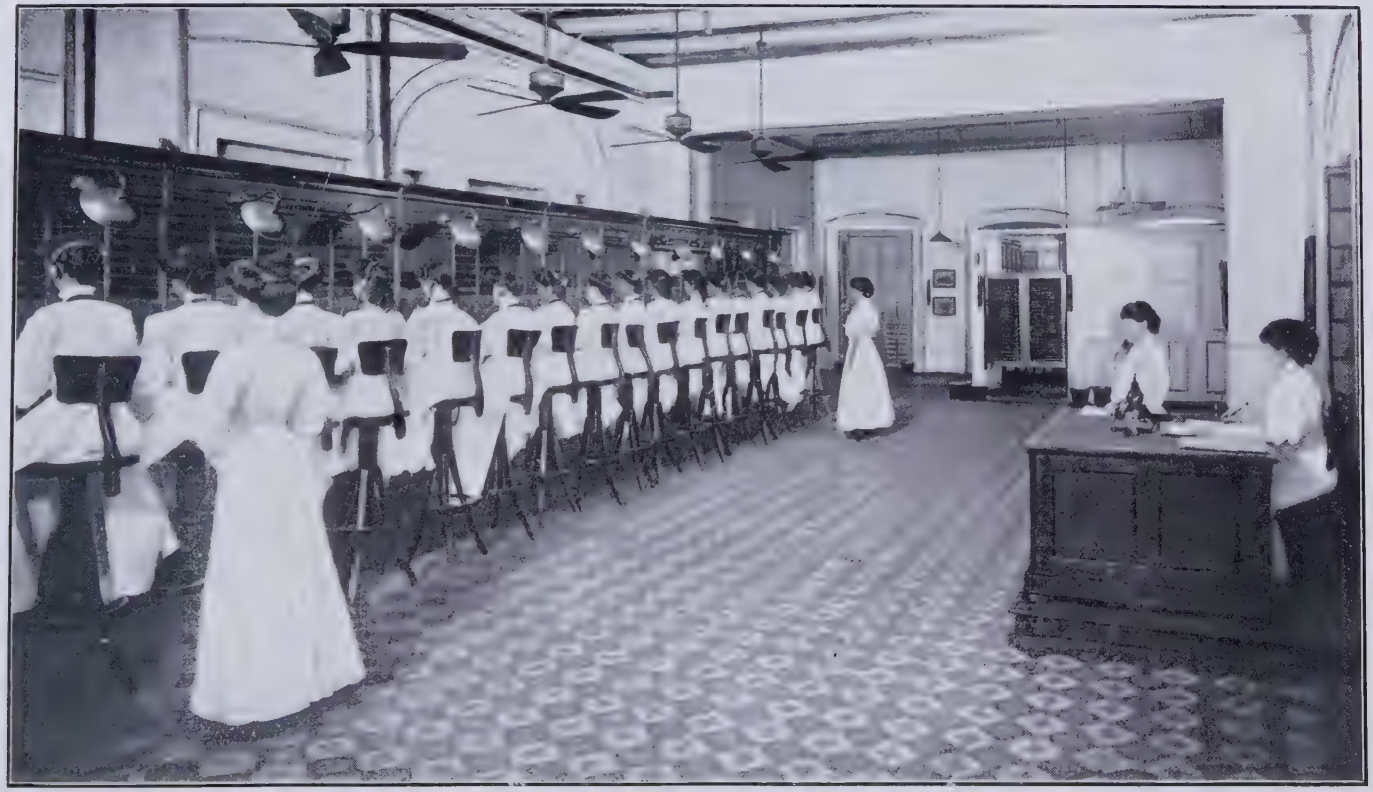

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